SCIENCE

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MODERN VIEWS ON THE CONSTITUTION OF THE ATOM

AT a meeting of the Royal Society of Canada held at Montreal, May, 1914, the writer gave by request a summary of recent work and ideas on the nature of the atom. The object was to concentrate, as clearly as possible, but not exhaustively, the results and opinions scattered through many different publications. Few men have time or opportunity to collect and analyze for themselves the large output bearing on this fascinating subject.

1. It may be well to call attention to the general bearing of the situation. Biologists are divided into three camps, vitalists, mechanists, and those who sit on the boundary fence. The mechanists believe that all phenomena relating to life are attributed to the action of physical and chemical processes only. The vitalists believe that life involves something beyond and behind these. Now those who investigate natural philosophy, or physics, are endeavoring with some fair initial success, to explain all physical and chemical processes in terms of positive electrons, negative electrons, and of the effects produced by these in the ether, or space devoid of matter.

If both the mechanists are right, and also the physicists, then such phenomena as heredity and memory and intelligence, and our ideas of morality and religion, and all sorts of complicated affairs are explainable in terms of positive and negative electrons and ether. All of these speculations are really outside the domain of science, at least at present.

2. It has been remarked by Poincaré that each fresh discovery in physics adds

a new load on the atom. The conditions which the atoms have to explain may indeed be written down, but to do so is merely to make a complete index for all books on physics and chemistry in the widest sense.

3. In the early days of the kinetic theory of gases, now well established in its broad outlines, it was sufficient to regard the atom as a perfectly elastic sphere, and it is about a generation ago[1] that leading savants were triumphantly determining the effective radius as about 10^{-8} cm. (a convenient shorthand for the hundred millionth of a centimeter).

The discovery of electrons as the cathode rays of an electric discharge in an exhausted tube, and as the beta rays of radium, opened up new regions.[2] It appears that negative electricity consists of electrons with their accompanying but unexplained effects in the ether. Electrons in motion produce magnetic fields. Their effective mass is about one eighteen hundredth part of that of a hydrogen atom, and their effective radius one hundred thousandth. The greatest known speed of electrons nearly approaches that of light.

The Zeeman effect, or separation of a single line in the spectrum by suitable magnetic fields, into two or more lines proved conclusively that the vibrations of negative electrons in the atom are the cause of the disturbances in the ether which we know as light.

4. The first scheme of an electronic atom, propounded by Sir Joseph Thomson, was a sphere of positive electricity, of undefined character within which revolved concentric rings of electrons in the same plane. There necessarily followed the simplicity of circular motion under a force to the center, proportional to the distance between the electron and the center of the atom.

5. Previous to this Lord Rayleigh had called attention to a serious anomaly. In a train of waves of a periodic character, the electric intensity E varies as the sine of nt, where t is the time and $2\pi/n$ is the period. As the equations involve the second differential of E, it appears inevitable that the square of n should appear in the law for spectral series. As a matter of fact there appears not the square of n, but n itself. It is desirable to be more explicit. If parallel light from a luminous source passes through a slit and a prism, together with suitable lenses, then the eye or photographic plate can detect a number of bright lines forming the spectral images of the slit for different colors, provided that the light is from luminous mercury vapor or hydrogen, or some such source. Many of these lines have been found to belong to one or more series crowding together towards the violet end. Balmer and Rydberg have found that the general type of formula for their frequency n is

$$n = N_0\left(\frac{1}{a^2} - \frac{1}{b^2}\right),$$

where N_0 is a universal constant called Rydberg's number, the same in value for *all* electrons of *all* atoms; and a and b are whole numbers or integers. We shall refer later to the importance of Rydberg's constant and of this magnificent generalization.

The trouble to which Rayleigh referred was first faced by Ritz in a startling manner. He imagined that there were inside the atom, placed end to end, a number of small magnets with an electron constrained to move in a circular path around the line of magnets. With this hypothesis he was

[1] Young proved this in 1805, but his work was forgotten, until Rayleigh called attention to it in 1890 (*Phil. Mag.*, XXX., 474).

[2] It is remarkable how little the general public has shared in this advance. In Montreal there were eleven thousand people witnessing a wrestling match while few availed themselves of an invitation to meetings and discussions of the Royal Society.

able to account correctly for the above law for series of lines in the spectrum.

We may appreciate Poincaré's criticism—

On a quelque peine à accepter cette conception, qui a je ne sais quoi d'artificiel.

Inasmuch as physicists endeavor to explain magnetism in terms of revolving electrons, there is a lack of simplicity, and there is an inconsistency, in introducing elemental magnets inside the atom. Nevertheless, it must be admitted that Weiss has found remarkable evidence for the conception of *magnetons* or elemental unit magnets, producing intra-molecular fields reaching to millions of Gauss units, far transcending any produced by our most powerful electromagnets, and difficult to explain by revolving electrons.

Again to quote Poincaré—

Qu' est-ce maintenant qu'un magnéton? Est-ce quelque chose de simple? Non, si l'on ne veut pas renoncer à l'hypothèse des courants particulaires d'Ampère; un magnèton est alors un tourbillon d'électrons, et voila notre atome qui complique de plus en plus.

Perhaps the hypothesis of Bohr, explained later, may overcome the difficulty, but for some time to come the more prudent will suspend judgment on the magneton.

Recently there has been nothing short of a revolution in physics. In certain domains, the leading workers and thinkers have deliberately abandoned the classical dynamics and electro-dynamics, and made suppositions which are in direct opposition to these. This startling change may perhaps be justified by the fact that the famous laws and equations were based on large scale experiments, so that they do not necessarily apply to conditions within the atom. Those who put forward and make use of the new hypotheses, men like Planck and Lorentz, Poincaré and Jeans and others, appear to do so with reluctance, like a retiring army forced from one position to another. Others, like Rayleigh and Larmer, appear to regard the whole movement with misgivings, and some endeavor, like Walker and Callendar, to find a way out. There is a young school who go joyfully forward, selecting and suggesting somewhat wild hypotheses, and yet attaining an unexpected measure of success by their apparently reckless methods.

The main phenomena to which the new mechanics have been applied are the radiation within an enclosure, and the distribution of energy therein; the high speed of electrons ejected from matter by ultraviolet light, or by Röntgen rays, or by the gamma or penetrating rays from radioactive substances, or as I suggest that we call them, from *radiants;* the atomic heat of elements, so admirably handled by Debye; the residual energy at low temperatures; and the constitution of the atom.

Space prevents us from considering more than the last of these.

The first step towards the new method was taken by Planck when he saw the necessity of explaining why the energy of short wave radiation is some hundred millionth part of that demanded by classical dynamics. He made the supposition that energy is not indefinitely divisible, but he did not assume that it was atomic. He actually imagined that energy was emitted from oscillators in exact multiples of hn, where n is the frequency of the oscillation and h is a universal constant (Planck's) with a value 6.5×10^{-27} erg second. The magnitude of the energy quantum is thus proportional to the frequency.

This quantum hypothesis has spread like fire during a drought. It pervades the scientific journals. No physicist has pretended to explain or understand it, for, as Jeans says, the lucky guess has not yet been made. Nevertheless, it appears that "h" has truth underlying it, and that it

has come to stay, for the applications of the quantum hypothesis have already achieved a great and unexpected measure of success. In the meantime it is necessary to proceed with caution, checking every theory by experiment, for there is no other criterion to guide the investigator, whether to hold to the old or try the new.

7. The first steps towards the idea of the modern or Rutherfordian atom rest on an experimental basis, and are not, therefore, open to suspicion.

Rutherford and Geiger found that when the alpha particles from a radiant, such as radium or polonium, met a thin gold leaf, the bulk of the alpha particles passed through with slight deflection, but about one in eight thousand bounced back, or returned towards the side of their source. Both large and small deviations of the alpha particles in passing through matter were satisfactorily explained by ordinary or Newtonian dynamics, with the law of repulsion inversely as the square of the distance between similar electric charges. One charged particle was the alpha particle with a positive charge twice as large, numerically, as that of an electron. The other charged particle was the *nucleus* of the atom of gold, and the magnitude of this charge was about $\frac{1}{2}A$ where A is the atomic weight of gold. This view was subjected to a searching series of experimental tests and emerged triumphant.

8. About this time C. T. R. Wilson skilfully obtained photographs of the mist-ladened, charged air molecules, marking the track of a recent alpha particle, in an expansion chamber. Some of these photographs showed where a collision had occurred between the alpha particle and one of the heavier molecules of air. It immediately occurred to Sir Ernest Rutherford that a collision between an alpha particle and a lighter atom, such as hydrogen, would result in the nucleus of the latter being projected beyond the known range of the alpha particle. The point was put to the test by Marsden, and a complete justification of Rutherford's nucleus resulted. The hydrogen nuclei were found to produce scintillations on a zinc sulphide screen at a range about *four times as great* as that of the alpha particles. Some mathematical investigations by G. C. Darwin indicated that the alpha particle or nucleus of helium, and the hydrogen nucleus must have approached so close that their centers were but 1.7×10^{-13} cm. apart. This affords further evidence of the extreme minuteness of the nucleus compared with the size of an atom (10^{-8} cm.).

9. It may be well to recall at this point an interesting result of Barkla, obtained some years earlier, who showed from the scattering of Röntgen rays that the number of electrons in the atom must be about $\frac{1}{2}A$, where A is the atomic weight. In the case of an uncharged atom, the positive charge on the nucleus must evidently balance the negative charges on the electrons revolving in orbits around that nucleus.

Thus we can form a clear mental picture of the general character of the atom. It is a miniature solar system. The sun is replaced by the positively charged nucleus. The planets, perhaps confined to one or more definite orbits or rings, are replaced by negative electrons revolving rapidly around the nucleus. The gravitational force is replaced by the electrical attraction between the positive nucleus and negative electrons.

10. A brilliant young Dane, Bohr, has gone a step farther and suggested the structure of an atom capable of explaining the series of spectral lines. His work is remarkable as leading to excellent numerical verification. He assumes the Rutherfordian nucleus of electronic charge about half the

atomic weight; he assumes that for every revolving electron in every atom the angular momentum is constant. To be concise, he supposes that for each electron mass $\times$ velocity $\times$ radius $=$ Planck's constant $/2\pi$.

He further supposes that in a steady stationary orbit even a single electron does not radiate away energy. *This is entirely contrary to classical electrodynamics.* Furthermore he imagines that in passing from one state of stationary orbit to the next possible, there is homogeneous radiation of amount hn, where n is the frequency. This is of course Planck's assumption, and it is certainly unexplained, and probably not in accord with Hamilton's equations as deduced from Newton's laws. Nevertheless, any day we may learn why energy is emitted *per saltum*, and this mystery will vanish.

Now if you permit these somewhat arbitrary assumptions to Bohr, he can and does deduce, at least for the lighter atoms such as hydrogen and helium, the Rydberg formula for the spectral series. He finds:

$$n = \frac{2\pi^2 me^4}{h^3}\left(\frac{1}{a^2} - \frac{1}{b^2}\right),$$

where n is the frequency; m, e, mass and charge of an electron; h is Planck's constant; a, b, are integers. The quantity before the bracket should equal the Rydberg number N_0, of observed value 3.29×10^{15}. Bohr's calculated value is 3.26×10^{15}, showing a most satisfactory agreement.

Bohr endeavors to account for the manner in which two hydrogen atoms form a molecule. Each atom has a nucleus of positive charge and a simple electron revolving around it. Their charges are equal and opposite. The nuclei of two such atoms repel each other. The revolving electrons of two atoms close together, if rotating in the same direction, constitute two parallel currents of electricity, and these attract one another and arrive in the same plane. It is easy to make a model on a whirling table with the nuclei on an upright rod, the electrons revolving like the governor balls of an engine. Bohr has gone further, and conceived a similar model of a water molecule with the two nuclei of hydrogen and one nucleus of oxygen in a straight line, with 10 electrons revolving in their zones around them. No doubt these suggestive schemes are somewhat speculative, but it is refreshing to find a first approximation to a dynamical scheme replacing the old unsatisfactory electrostatic atoms, which probably did not approximate to the truth. Some of the formidable organic molecules must have a complexity which it may take generations of physicists to unravel.

11. One of the triumphs of mathematical physics was the forecast of Laue that crystal bodies have their atoms so distributed that Röntgen rays must be diffracted by these atoms in the same manner that closely ruled crossed lines diffract visible light. This forecast and its rapid verification, enable the two Braggs, father and son, to measure with accuracy the wave-lengths of Röntgen rays. While the waves of visible light are of the order 10^{-5} cm., those of Röntgen rays are of the order 10^{-8} cm., about one thousandth of the former. The electromagnetic theory recognizes no intrinsic difference between the great waves of wireless telegraphy, several kilometers in length (10^6 cm.), short electric waves, long heat waves, visible light (10^{-5} cm.), ultraviolet waves, and Röntgen rays (10^{-8} cm.).

The method of reflecting Röntgen rays from a rock-salt or another crystal has been applied by Moseley with marked success to the determination of the nucleus charges of the atoms of most of the elements. He bombarded the elements one after the other, by electrons as cathode rays, reflected

the resulting Röntgen rays from a crystal and measured the wave-lengths of one or other of the principal (K or L, hard or soft) radiations.

In this manner he found

$$n = A(N - B)^2,$$

where n is the frequency of vibration, N the nucleus electronic charge, necessarily a whole number, and A and B are determined constants. In this manner he has found the *atomic numbers* N of all the known elements from aluminium 13 to gold 79. There appear to be but two or three elements not yet found by the chemists. These experimental results bear out well a view first propounded by van den Broek, that each element has an atomic number, an integer representing its place in the periodic table (H 1, He 2, Li 3, Be 4, Bo 5, C 6, and so forth). The atomic weight is not an exact integer, nor of such fundamental character as the atomic number. There will be further reference to this point later.

12. Rutherford has extended Moseley's method and results to the crystal reflection of the gamma rays from a radiant (Ra B), and determined the wave-lengths of many lines, in particular of the two strongest. He has bombarded lead with Ra B rays and found the wave-lengths of the radiation stimulated in the lead. He found that

Radiant	Rays	Atomic Number	Atomic Weight About
Uranium 1	α	92	238.5
Uranium X 1	β	90	234.5
Uranium X 2	β	91	234.5
Uranium 2	α	92	234.5
Ionium	α	90	230.5
Radium	α	88	226.5
Radium Em.	α	86	222.5
Radium *A*	α	84	218.5
Radium *B*	β	82	214.5
Radium *C*	α, β	83	214.5
Radium *D*	β	82	210.5
Radium *E*	β	83	210.5
Radium *F*	α	84	210.5
Lead		82	206.5 (207.1)

Radium B and lead gave the same spectrum, indicating that they have the same atomic number, 82. Hence he deduced the atomic numbers of all the radiants in the uranium-radium family. His results are worth repeating.

13. All of these results are in harmony with the wonderful advances in radiochemistry due to Soddy, Fajans, Von Hevesy and others. It has been found that when a radiant emits an alpha particle or helium nucleus, the chemical properties of the newly formed radiant differ from the old. A fresh element is formed, a different valency results, and the new radiant, relative to the old, is *two* columns to the *left* in the periodic table. The atomic number has decreased 2, and the atomic weight about 4. But when a radiant ejects a *beta* particle or electron, again there is a new radiant with different valency and chemical properties, but there is a move of *one* column to the *right* in the periodic table; a gain of one in the atomic number and no change in the atomic weight.

A brief example of the whole scheme applicable to all radiants is given below:

Column			
IV.	V.	VI.	At. Wts.
Ur X 1 → 90, β	Ur X 2 → 91, β	Ur 2 92, α	234.5
		Ur 1 92, α	238.5

In the case of these radiants Ur 1 ejects an α particle and gives rise to Ur X 1. The latter and Ur X 2, respectively, emit a β particle.

It should be added that the short-lived product Ur X 2 or "brevium" was discovered by this theory, after it had been formulated from the known behavior of other radiants.

It will be seen that Uranium 1 and 2 are

in the same column and have the same atomic *number*, but that their atomic *weights* differ by 4. Such substances have chemical properties so identical that they are called inseparables, or non-separables, or isotopes, for they occupy the *same* place in the periodic table. Thus the old trouble of finding places in the periodic table for the thirty or forty radiant elements has suddenly vanished. They may be superposed even when their atomic *weights* differ, if their atomic *numbers* are the same. The nuclear charges of isotopes must be identical, but the distribution of electrons may be different. Other examples of inseparables are:

Lead, radium B, Radium D, all 82.
Thorium and radiothorium.
Radium and mesothorium.

If these views are distasteful to chemists let them discover some means of the separation of the known isotopes.

It must be further noted that the results of radiochemistry appear to require the presence of negative electrons in the nucleus itself. The expulsion of a β particle, or one negative electron, from the nucleus is equivalent to the gain of one positive electron, and involves a unit increase in the atomic number.

14. The last advance is the most important and far-reaching. There has been long search for the positive electron, and in vain; yet it seems likely that it has been under our eyes all the time. Since the hydrogen atom never loses more than a single electron, is it not possible, suggests Rutherford, that the nucleus of the hydrogen atom may be the positive electron?

The electro-magnetic mass of an electron is $\frac{2}{3}\frac{a}{e^2}$ where e is the charge and a the radius. If the mass of the hydrogen nucleus is wholly electro-magnetic, then its radius must be smaller than that of the electron (negative) as 1:1800, for that is the ratio of their masses, while their charges are equal and opposite. Hence we have

	Mass	Diameter
Atom	1	10^{-8} cm.
Negative electron	1/1800	10^{-13}
Positive electron	1	10^{-16}

Rutherford cautiously remarks that there is no experimental evidence against such a supposition.

Those who wish to follow the matter deeper must refer to many articles in the *Philosophical Magazine*,[3] several letters to *Nature*, Soddy's "Chemistry of the Radio-elements," part II., and Perrin's "Les Atomes." The chief writers have been Rutherford, W. H. Bragg, W. L. Bragg, G. C. Darwin, Moseley, Broek, Bohr, Russell, Fajans, Soddy, Hevesy, Nicholson and Mardsen.

Much has yet to be done, and much to be revised, but that the first great forward strides have been taken in the right direction there can be little doubt.

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STATISTICS OF CROPS

DEGREE OF ACCURACY OF THE REPORTS OF THE BUREAU OF STATISTICS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

IN the March 28, 1913, number of SCIENCE, Dr. C. G. Hopkins gives a discussion of this topic under the title of "Facts and Fiction about Crops." The Department of Agriculture is accused of "condemnable inflation of crop statistics." The writer does not believe that such a conclusion would be reached if the reports were more carefully studied.

He shows the percentage of error to be very great when the Bureau of Statistics estimates of corn in the southern states are compared with the census report. If the error is due to wilful deception, we should expect to find the

same over-statement in the important corn states.

The largest error is in the case of Louisiana, where the Bureau of Statistics report of corn is 97 per cent. above the census report for 1909, being an error of 25 million bushels, but the crop of Iowa was underestimated by 52 million bushels. The corn crop of the United States was overestimated by 9 per cent. But a careful study of the methods of enumeration makes this error less conclusive. By the census method of enumeration, corn grown for silage is unfortunately put with coarse forage crops. It ought to be enumerated separately. There were over four million acres of such crops, of which corn certainly made up the larger part. By the methods used by the Bureau of Statistics, much silage corn is doubtless included with other corn. It is probable that this would reduce the error to 5 or 6 per cent.

A study of Table I. shows that of the thirteen crops reported, the production was underestimated on six crops, overestimated on six crops and practically correct on one crop. Of the six most important American crops, three, hay, cotton and potatoes are underestimated, oats were correctly estimated, while only two, corn and wheat were overestimated. Certainly there is no indication of wilful exaggeration. The most serious error is in the underestimate of the hay crop. Census reports include salt-marsh hay and all wild hay. It is probable that many crop reporters do not consider any of this as hay except that portion that is used for stock food. But even making an allowance for this difference, it is certain that the Bureau of Statistics reports are too low.

Careful study of Table I. and of the reports for individual states indicate that the errors in individual states may be very large, but

TABLE I

COMPARISON OF CENSUS AND YEAR-BOOK REPORTS OF CROPS IN THE UNITED STATES IN 1909[1]

Yields of grain are given in bushels, hay in tons, cotton in bales, tobacco and hops in pounds.

	Acreage			Production			Yield Per Acre		
	Census Report	Year-Book	Per Cent. Error	Census Report	Year-book	Per Cent. Error	Census Report	Year-book	Per Cent. Error
Corn	98,382,665	108,771,000	11	2,552,189,630	2,772,376,000	9	25.9	25.5	−2
Wheat	44,262,592	46,723,000	6	683,379,259	737,189,000	8	15.4	15.8	3
Oats	35,159,441	33,204,000	−6	1,007,142,980	1,007,353,000	0	28.6	30.3	6
Barley	7,698,706	7,011,000	−9	173,344,212	170,284,000	−2	22.5	24.3	8
Rye	2,195,561	2,006,000	−9	29,520,457	32,239,000	9	13.4	16.1	20
Buckwheat	878,048	834,000	−5	14,849,332	17,438,000	17	16.9	20.9	24
Potatoes	3,668,855	3,525,000	−4	389,194,965	376,537,000	−3	106.1	106.8	1
Hay and forage	72,280,776	—	—	97,453,735	—	—	1.35	—	—
Hay	62,784,663[2]	45,744,000	—	80,302,526[2]	64,938,000	—	1.28[4]	1.42	—
Cotton	32,043,838	30,938,000	−3	10,649,268	10,004,949	−6	0.33	0.32	−3
Tobacco	1,294,911	1,180,000	−9	1,055,764,806	949,357,000	−10	815.3	803.3	−1
Flaxseed	2,083,142	2,742,000	32	19,512,765	25,856,000	33	9.4	9.4	0
Rice	610,175	720,000	18	21,838,580	24,368,000	12	35.8	33.8	−6
Hops	44,693	—	—	40,718,748	36,000,000	−12	911.1	—	—

[1] Year-book reports are from the Year-book of the United States Department of Agriculture for 1909 except the acreage of cotton, which is as reported in the 1910 Year-book. The production of cotton is the estimate as reported by the Bureau of the Census in the 1910 Year-book.

[2] The Census report for grasses, clover and alfalfa. These figures may not be exactly comparable with hay as reported by the Bureau of Statistics.

that the results for the United States are accurate enough to be very useful.

The percentage error is most likely to be high in states that grow little of the crop. The same is true of census reports. The error is also likely to be large in regions that are making the largest change in the area or yield of the crop.

The errors are the result of cumulative

errors. It is unfortunate that the Bureau did not adjust its figures to the census basis in 1899. This has been done since 1909 so that we may expect a much smaller error in the future as the error will be corrected at each census year. each year to be corrected so that the error from year to year would not be cumulative.

ARE OUR CROP YIELDS DECREASING?

In the same issue Dr. Hopkins discusses the question of crop yields. The conclusion

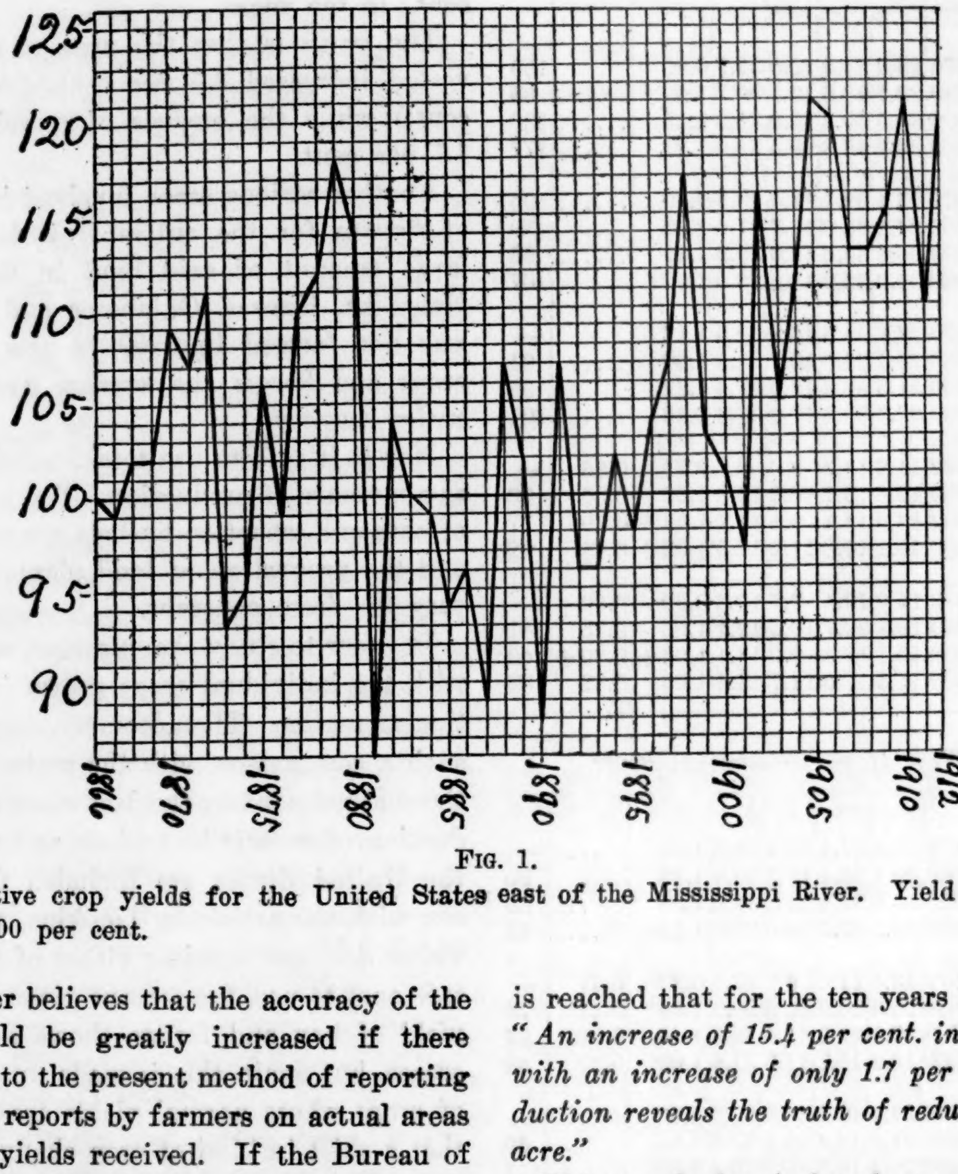

FIG. 1.

Comparative crop yields for the United States east of the Mississippi River. Yield of 1866 considered as 100 per cent.

The writer believes that the accuracy of the reports could be greatly increased if there were added to the present method of reporting a system of reports by farmers on actual areas grown and yields received. If the Bureau of the Census could send a large number of letters to farmers each winter asking for the area of the farms, area of each crop grown and total yield, these reports could be compared with reports from the same farms for previous years. The changes in areas of farms, failures of some men to report and other problems involved, would not, in the writer's opinion, be at all insurmountable. This information would allow the final report for

is reached that for the ten years 1899 to 1909, *"An increase of 15.4 per cent. in farmed land with an increase of only 1.7 per cent. in production reveals the truth of reduced yield per acre."*

This conclusion is based on serious errors in the use of statistics. The production used is the total bushels of cereals. The acreage used is the area of improved land in farms. This land is not all farmed, much less is it all planted to cereals.

The census report states that

Improved land includes all land regularly tilled or mowed, land pastured and cropped in rotation, land lying fallow, land in gardens, orchards, vine-

yards and nurseries, and land occupied by farm buildings.

TABLE II

States East of the Mississippi River

		All Cereals, Bu.	Corn, Bu.	Wheat, Bu.	Oats, Bu.	Hay and Forage, Tons	Cotton, Bales	Potatoes, Bu.
New England..	1879	28.0	34.5	15.5	32.7	0.96		109
	1889	29.7	38.6	19.1	30.7	1.09	......	85
	1899	34.5	39.4	18.0	35.9	1.13	......	130
	1909	36.2	45.3	23.5	32.9	1.23	......	177
Middle Atlantic...	1879	23.4	33.1	14.1	28.5	1.10	......	95
	1889	24.1	32.8	16.7	27.4	1.29	......	70
	1899	25.3	34.0	14.9	30.9	1.19	......	95
	1909	24.6	32.2	18.6	25.5	1.32	......	107
East North Central...	1879	27.8	34.6	16.8	31.8	1.17		—
	1889	29.1	34.3	15.7	34.5	1.30	......	91
	1899	31.5	38.3	12.9	37.4	1.22		85
	1909	32.7	38.6	17.2	33.3	1.38	......	101
South Atlantic...	1879	11.8	13.3	8.8	9.9	0.84	0.35	—
	1889	12.5	13.7	10.3	10.8	1.09	0.35	70
	1899	13.0	14.1	9.5	11.7	1.02 –	0.39	77
	1909	15.1	15.8	11.9	15.5	1.02 +	0.45	92
East South Central...	1879	15.9	19.1	7.7	10.3	0.82	0.39 –	—
	1889	18.1	20.7	10.6	12.1	1.06	0.35	81
	1899	16.1	18.4	9.0	11.1	1.03 +	0.39 +	63
	1909	17.5	18.6	11.7	13.4	1.03	0.32	82

States West of the Mississippi River

		All Cereals, Bu.	Corn, Bu.	Wheat, Bu.	Oats, Bu.	Hay and Forage, Tons	Cotton, Bales	Potatoes, Bu.
West North Central...	1879	26.8	37.4	10.6	28.9	1.32	......	—
	1889	29.1	36.4	13.2	30.9	1.26	......	90
	1899	24.8	31.4	12.2	32.0	1.34	......	95
	1909	23.1	27.7	14.9	27.5	1.33	......	92
West South Central...	1879	13.4	14.0	6.6	17.0	0.82	0.47	—
	1889	20.0	20.9	10.6	20.2	1.35	0.41	73
	1899	20.6	21.9	11.9	25.8	1.48	0.39	67
	1909	15.9	15.7	11.0	21.4	1.03	0.27	63
Mountain...	1879	21.1	16.6	18.8	28.9	1.13	......	—
	1889	21.3	14.4	20.0	27.8	1.36	......	69
	1899	22.4	16.5	19.2	30.4	1.59	......	113
	1909	26.5	15.8	23.1	34.9	1.73	......	143
Pacific......	1879	18.6	27.1	16.3	30.5	1.45	......	—
	1889	17.3	30.2	15.0	28.4	1.49	......	95
	1899	18.7	25.2	15.6	31.4	1.44	......	129
	1909	21.7	24.0	17.7	35.3	1.73	......	131

United States

		All Cereals, Bu.	Corn, Bu.	Wheat, Bu.	Oats, Bu.	Hay and Forage, Tons	Cotton, Bales	Potatoes, Bu.
	1879	22.7	28.1	13.0	25.3	1.15	0.40	—
	1889	25.1	29.4	13.9	28.6	1.26	0.37	84
	1899	24.0	28.1	12.5	31.9	1.28	0.39	93
	1909	23.6	25.9	15.4	28.6	1.35	0.33	106

If the area of cereals bore a constant ratio to all improved land, the final conclusion might have been correct in spite of the error in method used, but this is far from the case. Other crops have increased much more rapidly than cereals. The area of cereals increased 3.5 per cent., and other crops increased 22 per cent., in ten years.

The truth is that the area of cereals harvested increased 3.5 per cent. (not 15.4 per cent.) while the bushels of cereals increased 1.7 per cent.

Another serious error involved is in the use of figures for the entire United States. A large amount of arid land in the Dakotas, Nebraska, Kansas, Oklahoma and Texas that was not farmed in 1899 is now planted to crops and lowers the average yields for the entire country.

Nor is it safe to use total bushels of cereals as a measure of production. The normal yields of oats and wheat in bushels are not the same and the proportion of land planted to each is very far from constant.

In order to study the question, we must deal with the individual crops grown in some particular region. The accompanying table gives such a comparison with the states grouped by the method used in the last census. The production of cereals in bushels and averages for the United States are included for comparison with the article by Hopkins, although the writer does not consider either of these figures safe ones to use, for reasons given above. The yield of hay and forage shows a decided increase, but again this is made up of a number of crops whose normal yields are different, so that a shift in kind of crop changes the yield.

In the states east of the Mississippi River, comparatively little new land has been added to farms in the last twenty years. For this reason these states are the ones that give the best information as to changes in crop yields.

The highest yield of cereals ever reported by the census for New England, the East North Central, and South Atlantic, states is the crop of 1909. In the Middle Atlantic states, the highest yield ever reported is for 1899 with

1909 second. In the East South Central states 1889 is first with 1909 second.

The Corn Crop.—The highest yield per acre of corn reported by the census for Illinois, Indiana, Ohio, is for 1909. The total for all states east of the Mississippi River gives 1909 as the highest yield, but in some of the groups of states there have been better yields. The fact of a lower yield for the entire country in 1909 is not, therefore, as is commonly stated, due to a decrease in yields in the older states.

Wheat.—The highest yield of wheat reported in any census year is for the year 1909, with an average of 15.4 bushels. The nearest competition was the year 1889, when the yield was 14 bushels. The year 1909 is the best year ever reported in each of the groups of states except in the West South Central.

Oats.—In the New England, Middle Atlantic and East North Central states, the best oat yield reported by the census is for 1899. For the southern states east of the Mississippi, the best year reported was 1909.

Hay and Forage.—The highest yield per acre of hay and forage ever reported is for the year 1909. As stated above, this figure should not be given too much weight, because shifts in acreage of the different kinds of crops in this collective group might affect the result.

Potatoes.—The highest yield per acre of potatoes ever reported by the census is the last report. This is true for each of the groups of states east of the Mississippi River. The only groups that show a decrease are the West North Central and West South Central.

Cotton.—The old South Atlantic states reported by far their best cotton crop for the year 1909. The best report from the East South central states is for 1899. The cotton yield per acre for the entire United States was lower in 1909 than in any other census year, but this is in spite of high yields in the old Atlantic states. The area of cotton in the United States increased nearly one third in the ten years. This increase was mostly due to extending the crop on arid lands and on other lands that were considered too poor to farm ten years before. The West South Central states, where most of the new arid land has been added, have shown a steady decrease in yield. Oklahoma increased its area by 190 per cent., but production increased only 146 per cent. Low yields in Oklahoma should not be charged to soil exhaustion in Georgia. The poor results in Texas and some of the other neighboring states are also partly due to the boll weevil as well as to season and soil.

Considering the above five different regions east of the Mississippi River and the six important crops, corn, wheat, oats, hay and forage, cotton and potatoes, we find the following:

Number of instances of first rank in crop yield:

1879	*1889*	*1899*	*1909*
0	3	5	19

These figures show very strikingly the general increase in crops in later years in these older states.

For the West North Central and West South Central groups, there is only one instance in which the 1909 yield is the best. In these states there appears to be a general decrease in production. This difference is primarily due to the bringing in of arid land that was not formerly used. The Mountain and Pacific states show a general increase in yields.

REPORTS BY THE BUREAU OF STATISTICS

A better method of comparing crop yields is on the basis of the reports by the Bureau of Statistics because these yields are secured for every year. The amount of rainfall in any particular year makes the figure for a single year inconclusive.

As has been previously shown, the Bureau of Statistics estimates the yields of the important crops with a fair degree of accuracy. The yield per acre of corn for 1909 was estimated at 2 per cent. less than the census results. The yield per acre of wheat was 2 per cent., oats were 6 per cent. and potatoes 1 per cent. higher than census returns.

Fig. 1 shows the comparative yields of corn, wheat, oats, barley, rye, buckwheat, potatoes and hay in states east of the Mississippi

River based on the 1866 yield as 100 per cent. The comparative yields of each crop, considering the 1866 crop as 100 per cent., were calculated. These percentages were weighted according to the area planted to the crop in order to secure a percentage representing the yield of that year.

G. F. Warren

Cornell University

STANFORD UNIVERSITY MEDICAL SCHOOL

Dr. Victor C. Vaughan, dean of the department of medicine and surgery of the University of Michigan, has made, under date of June 9, 1914, the following report to Dr. J. C. Branner, president of Leland Stanford Junior University:

In compliance with your telegraphic request I have visited Palo Alto and San Francisco and inspected the libraries, laboratories and hospitals of Stanford University. The laboratories of chemistry (general, physical, inorganic, organic and physiological), biology, histology, neurology and physiology are well housed, adequately equipped and exceptionally well manned. In all these, high grade work is being done. The laboratories of bacteriology and anatomy need better housing and I understand that this is to be provided in the near future. But in the buildings now occupied, most excellent work is being done. In fact each of the scientific departments at Stanford is under the direction of an eminent man supplied with able and enthusiastic assistants and with necessary equipment. There is abundant evidence even in a hasty inspection that the appropriations have been economically and wisely expended and that good work is being done both in instruction and in research. I wish to compliment the trustees and president upon the evident wisdom which they have displayed in the development of these departments of the university. What I have said of the scientific branches is equally true of the other departments of Stanford University. Although one of the youngest of the higher institutions of learning in this country Stanford ranks as one of the best in all departments, both scientific and humanistic. In all branches it represents the highest aims and ideals. While I am not fitted to express anything more than a general opinion as to other than scientific education I wish to emphasize the fact that all learning is one and the same spirit should pervade the whole. This I believe to be true at Stanford. It furnishes a wholesome atmosphere in which the student can grow whatever special line of training he may follow later. The greatest need of our country is the man whose fundamental knowledge is broad and comprehensive and whose special training is exact. No man can have useful knowledge of a part unless he has general knowledge of the whole. The working of the part must be in harmony with the movements of the whole; otherwise disaster is the result. While I am especially interested in medical education, I recognize the fact that it is futile to try to develop a good medical man out of one whose fundamental training has not been sound. The young man who has learned to work with the right spirit, whether it be in Greek or biology, in philosophy or chemistry, will enter medicine, law or any profession in the right frame of mind and will be likely to prove an honor in his chosen profession. In his preliminary college training the prospective medical student should not be confined to the physical or biological sciences. It is desirable that he know the classics, history and philosophy and it is most desirable that the training that he gets along these lines should be of the highest grade. I believe that Stanford University furnishes suitable conditions for the development of the young man who is going into medicine. Therefore I hope that the medical work done at Palo Alto may continue. If the medical school should be closed, this would relieve Stanford of only one of the laboratories at Palo Alto. Physics, chemistry, biology, physiology, histology, embryology, neurology and bacteriology must be taught and research work in these branches must be done in a university of the high rank Stanford holds. Closing the medical school would give only trifling financial relief to the university. I therefore recommend that the premedical and medical work now done at Palo Alto be not only continued but be developed as fast as the finances of the university permit. I make this recommendation not only for the good of the medical school, but, as I believe, in the interest of the university as a whole. If the medical department should be discontinued, anatomy is the only subject which could be dropped at Palo Alto and even then this should not be done. Anatomy is one of the great and fundamental biological sciences and even human anatomy should be taught in a great scientific university. Anatomy is no longer taught as a mere foundation for medicine and surgery. It includes the development of structure from the lowest to the highest forms of life.

I went to San Francisco and made an inspection of the library, hospital and laboratories of the medical school.

The Lane library is one of the best medical libraries in the country. It is supplied with practically all the best medical journals so arranged as to be most available to members of the faculty and students. Its location in regard to the hospital and laboratories is quite ideal. It is worth much to both the clinical and the research man to have at his hand the best contributions of the world. When a problem comes up for solution the first thing to learn is to ascertain what has already been done along this line. A medical school without a library is like a boat without a pilot and much time is likely to be lost in drifting. The medical department of Stanford is fortunate in the possessing of its library.

While the present hospital building is somewhat out of date it is, so far as I can see, admirably managed both in caring for the sick and in the instruction of students. The out-patient department, systematized as it is, is both a great, broad and needful charity and at the same time a source of varied and comprehensive instruction to students. The addition soon to be made to the hospital will modernize the institution. It will bring more pay patients to the institution and thus furnish the funds with which the less fortunate can be cared for. I was greatly pleased with the management of the hospital. The laboratories in the hospital are ably conducted and fairly well equipped. Some of them will probably have enlarged and improved quarters when the addition is made to the hospital.

As I understand the total cost of the medical department is now about one hundred thousand dollars per year. This cost will slowly increase. Notwithstanding this fact I strongly urge that the medical school be not only continued but be developed. In its development the quality of its work should be constantly held in mind. The number of medical students should be kept small. Quality and not quantity should be the aim. I believe that in the near future the medical department will be a source of strength to the university in many ways. First, in the importance of the research done and the benefits that such research will confer on the race. Within the past thirty years the average human life has been increased nearly fifteen years and the whole of life has been made more comfortable. This is a work to which a great university should contribute. The opening of the Panama Canal will bring to the Pacific coast many health problems which can be best solved in such a school of instruction and research as I believe Stanford will develop. Second, I am firm in the belief that the medical school will attract large donations, both for research and the clinical work. Philanthropists will see that the best service they can render lies in the direction of improved health conditions. Third, medicine is now attracting to its ranks many of the best of our young men and this will be a source of strength to the university.

Lastly, I come to the matter on account of which I was called to visit you. The time may come when it may be wise to consolidate the two university medical schools of San Francisco, but I do not believe that this would be wise at present. Stanford, from what I can learn, can afford to develop its medical school without material hindrance in the growth of other branches and I believe that this is the wise thing to do.

I am aware of the fact that a hasty visit, such as I have made, may give erroneous impressions and I would not have you attach any great importance to this report, but I have tried to look at matters from a broad viewpoint and to hold constantly in mind the good of Stanford University as a whole. I have considered it unnecessary to go into financial or other details with which you are much more familiar than I am.

In conclusion I wish to thank you, . . . and Dr. Wilbur and other members of your faculty for the many courtesies shown me and to express the hope that the growth of Stanford University during the past quarter of a century, phenomenal as it has been, may be surpassed in its future developments.

With great respect, I am

Yours most respectfully,

V. C. VAUGHAN

NEWTON HORACE WINCHELL

THE tribute I can render to the late Professor Winchell must be such as would quite spontaneously come from any one who had watched, with appreciation and sympathy, the progress of geological science in America during the past generation. I can not speak of Professor Winchell from a close personal intimacy, but I may, as one of many who highly regarded his very unusual achievements in one science and his broad, effective interest in sev-

eral others, express the esteem of his colleagues for the record he has left.

The science of geology renders high service to her followers in return for services rendered to her; she carries them far afield and opens up to them the guiding influences of all activities which have to do with the earth. If "an undevout astronomer is mad," even so is an uninspired or narrow-minded geologist. I am sure every geologist of long and loving contact with the earth feels that he is "the freeman," the real proprietor of "the varied fields of nature"; "the mountains, and the valleys and the resplendent rivers" are "by an emphasis of interest his." They are a heritage into which the acolyte but gradually comes, for the devotees of this science must render first an implicit and exclusive service to her elementary factors before they can venture far from her leading strings. They must first be "mere computers and measurers" to whom the science is no more than "chemical analyses, calculations of times and distances, labeling of species," men who "are seeking scientific knowledge for its proximate values" until such time as they grow into "an increasing consciousness of its ultimate value in the transfiguration of things."

In looking over the accounts which have been given in tributes already rendered to Professor Winchell's career, there stands out with perfect clarity the fact of his undivided devotion to geology through long years, when once he had found his measure, and the climax of this service was the execution from inception to end of the *Geological and Natural History Survey of Minnesota;* but even this finely rounded work was but a stepping stone to broader human relations.

Professor Winchell, like his distinguished elder brother Alexander, Professor Orton, Major Powell, O. C. Marsh, Israel C. Russell, all geologists of great eminence, was a child of New York. The venerable Geological Survey of New York would like to feel that it had had some influence in giving direction to the notable careers of these men. It may have been so in a measure, though perhaps least of all in Professor Winchell's case, for the hard scrabble farm on the sadly confused rocks in the town of North East, Dutchess county, where he was born and passed his childhood, may hardly have developed such a tendency toward an after lifework, no matter how much the constraints of a sterile soil might contribute to sturdy robustness of physique and character.

It has been said that Professor Winchell's performance in the execution of the Minnesota Survey has not been equalled in the history of American geology. The act providing for this comprehensive service was not drawn by him or enacted for him, but upon its passage in 1872 he was called from Ann Arbor and put in charge of the work. The organization that began with him ended in him, and, in view of its scope, his record is unique.

The plan of this undertaking, says Dr. Folwell, who as president of the University of Minnesota drew the bill and secured its enactment, was to have the work carried on by the members of the university faculty and this was done for a while, Professor Winchell holding the double position at the head of the survey and of the department of geology, but the increasing duties of the former compelled an eventual divorce of the two. For twenty-eight years without interruption he carried forward this scientific survey of a commonwealth covering eighty thousand square miles of territory and when the work was done or "the survey closed," as it is rather unhappily said, the information acquired and the problems discussed and the potentialities indicated had been presented to the world in a series of twenty-four annual reports, ten bulletins and six imposing quartos. It is distinctly to the credit of Winchell that he was never really succeeded in office. His state regarded his duty discharged and his work well done; but it did not stand so much to the credit of Minnesota that it could regard a geological survey as ever "closed."

The selection of Professor Winchell for a work of such importance to his state shows by its event, the wise insight of those who had the hopes of the organization in their keeping. There were still "geologists" in those days:

none are left now. The "all round" man competent to advance with equal foot along the many divergent lines of this comprehensive science, exists no longer. The "State Geologist" now may know one route expertly, others less well and some not at all, but with a capacity for good generalship he can yet perform the functions of his office without a masquerade. Professor Winchell was a sturdy, honest geologist with an extraordinary capacity for work and a reliable judgment in organization. He was more than that: his real interests in the science were very broad and he himself entered many fields. His first interest was in the chemistry of the rocks, their mineralogy and origin. He wrote on every phase of geological industry, from mining to water supply and agriculture; on Archean geology with an extensive personal acquaintance; intimately on optical mineralogy and petrography; somewhat profusely on the succession and significance of glacial phenomena; the complicated and sadly mistreated Taconic question he discussed with eminent fairness, and the sheaf of his reviews in the *American Geologist* indicates the still wider reach of his interests. That he desired to share in all departments of his organization is evinced by his titular co-authorship with Professor Schuchert in treatises on paleontology for his final reports, a field into which he would hardly have ventured alone.

The exploitation of all these fields was the legitimate duty of his organization and he led the way into all. And in addition to these services he did not ignore the fact that he was carrying on a "Natural History" as well as a Geological Survey, as several of its bulletins indicate. There will be no more such geological surveys in this country, into all of whose parts the chief can enter with skill and reasonable finality, and this fact makes the performance of Winchell one of which he was indisputably the author, and the great storehouse of the data he assembled in the best years of his labor is a monument of distinction to him and to the state which authorized it.

Professor Winchell's later interest as state geologist had been among the events of the ice age and the postglacial waters. These investigations, of high worth and broad concern, easily led him into a field with many pitfalls: primitive anthropology. He traversed this field with care and came out into much safer ground: the culture of the aborigines. This latter study absorbed the attention of the years after his survey had closed, and in 1911, under the auspices of the Minnesota Historical Society, he published a quarto of over 700 pages on the "Aborigines of Minnesota."

We can not attempt to analyze more closely here Professor Winchell's publications. They were numerous and varied but they do not by any means show forth his full service to science. He was the promoter, founder and chief editor of the *American Geologist,* a monthly journal whose annual financial deficit in the service he personally bore for the eighteen years of its existence. It was a catholic and helpful exponent of the science and there are many who still regret the transmigration of its soul.

At the last annual dinner of the Geological Society of America, Professor Winchell gave an explicit account of the organization of that society in which he played a prime part as proposer and founder, and his interest was acknowledged by his election to its presidency a few years after the organization was effected. He was one of the founders of the Minnesota Academy of Science and thrice its president, and a member of a number of scientific, historical and archeological societies.

It would be interesting to find the real clue to Professor Winchell's intellectual inclinations and singleness of purpose. Looking both forward and back from his personality, there seems an almost obvious "continuity of the germ-plasm" marked partly by his extraordinary presentation to his science of three distinguished devotees: his sons, Dr. Horace V. Winchell, Professor Alexander N. Winchell, and his son-in-law, Dr. Ulysses S. Grant. Some part of his impulses must have come from his tutelage and association with his brother, Alexander Winchell, at Ann Arbor, where he received his first sure direction into paths that led him for periods of service into

the geological surveys of Michigan and Ohio. It would indeed be worth while to know if the germs which impelled this noble pair of brothers into the same paths may really not have been picked up on the old home farm in Dutchess county, N. Y. Supervening all these early influences and regulating all their impulses, there was in the home, as is well known to many American geologists, a wise and gentle adviser in all the enterprises of his manhood, the unseen hand that kept the harp in tune.

John M. Clarke

SCIENTIFIC NOTES AND NEWS

Dr. Ira Remsen, ex-president of the Johns Hopkins University; Dr. L. H. Bailey, formerly director of the State College of Agriculture of Cornell University; Professor T. C. Chamberlin, of the University of Chicago; Professor Edwin G. Conklin, of Princeton University; Professor William M. Wheeler, of Harvard University, and Dr. Charles D. Davenport, director of the station of experimental evolution of the Carnegie Institution, planned to sail from San Francisco on the steamer *Tahiti* on July 22, to attend the Australasian meeting of the British Association for the Advancement of Science as guests of the New Zealand government.

Officers of the American Ornithologists' Union elected for the coming year are as follows: Albert K. Fisher, *president;* Henry W. Henshaw and Witmer Stone, *vice-presidents;* John H. Sage, *secretary;* Jonathan Dwight, Jr., *treasurer;* Ruthven Deane, William Dutcher, Frederic A. Lucas, Wilfred H. Osgood, Chas. W. Richmond, Thos. S. Roberts, and Joseph Grinnell, members of the council.

Dr. George H. Whipple, associate professor of pathology in Johns Hopkins Medical School, has been appointed director of the Hooper Institute, San Francisco.

Dr. Oscar Teague, of the Cornell University Medical School, has been appointed director of the new bacteriological laboratory of New York City at Quarantine.

The trustees of the Albert Kahn Travelling Fellowships have appointed Mr. Alan G. Ogilvie, of the School of Geography, Oxford University, a fellow of the British Foundation for 1914–15.

Captain J. F. Parry has been appointed to succeed Rear-Admiral Herbert E. P. Cust, C.B., as hydrographer of the British navy.

The University of Liverpool has conferred on Dr. T. F. Wall, lecturer on electrical engineering at the University of Birmingham, the degree of doctor of engineering.

Dr. Lemoine, professor of clinical medicine at Lille, on the occasion of the twenty-fifth anniversary of his teaching was presented with a picture of himself, painted by M. Pharaon de Winter.

The Mackinnon studentship of the Royal Society on the biological side has been awarded to Mr. G. Matthai, of Emmanuel College, Cambridge, for a research on the comparative anatomy of the Madreporaria.

The Emile Chr. Hansen prize for 1914 has been awarded to Professor Jules Bordet, director of the Institut Pasteur of Brabant.

The committee has awarded the Alvarenga Prize of $180 to Dr. Herman B. Sheffield, of New York, for his essay entitled "Idiocy and the Allied Mental Deficiencies in Infancy and Early Childhood."

The American Anthropologist states that the Cayuga County Historical Society of Auburn, New York, conferred the "Cornplanter Medal for Iroquois Research" on Mr. J. N. B. Hewitt of the Bureau of American Ethnology, Washington, D. C., for his work in the field of Iroquois anthropological study. The Cornplanter medal was founded in 1901 largely through the efforts of Professor Frederick Starr, of the University of Chicago, and a number of his friends who aided in providing the necessary means. The administration of the Cornplanter medal for Iroquois Research was then undertaken by the Cayuga County Historical Society. Four classes of workers are eligible to receive it, namely: (*a*) Ethnologists making worthy field-study or other inves-

tigations of the Iroquois; (b) Historians making actual contributions to our knowledge of the Iroquois; (c) Artists worthily representing Iroquois life or types by brush or chisel; (d) Philanthropists whose efforts are based on adequate scientific study and appreciation of Iroquois needs and conditions. Those who have previously received the award of the medal are, in their order, General John S. Clark, of Auburn, N. Y.; Rev. William M. Beauchamp, of Syracuse, N. Y.; Dr. David Boyle, of Toronto, Canada; Hon. William P. Letchworth, and Reuben Gold Thwaites.

Mr. H. R. Schmitt, of the Carnegie Department of Terrestrial Magnetism, completed successfully, early in July, a magnetic exploratory trip across Chile and Bolivia, from the Pacific coast to Corumba, Brazil.

Dr. Lew Chee, Peking, is visiting the United States, to inspect hospitals for information to be used in the construction and management of a hospital to be built in Canton next year at a cost of $750,000.

Father Cortie is arranging an eclipse expedition to Hernösand. The party will consist of Father Cortie, Father O'Connor, Mr. J. J. Atkinson and Mr. G. J. Gibbs.

Mr. C. Boden Kloss is engaged in an expedition, with Mr. H. C. Robinson, director of museums, Federated Malay States, to Mount Indrapura or Korinchi in Central Sumatra—a volcano 12,700 feet high and the highest summit in the island. The objects of the expedition are zoological and botanical, but it is hoped to ascend to the summit of the mountain and make observations of the crater and the present activity of the volcano.

In noting the election of M. Lacroix to the permanent secretary of the Paris Academy of Sciences in the issue of Science for July 10, his Christian name should have been given as Alfred.

The tenth session of the Congrès Préhistorique de France will be held at Aurillac (Cantal), from August 23 to 29, under the presidency of M. Pagès-Allary.

The Canadian government has decided that the new observatory to contain the six-foot reflecting telescope is to be situated on Little Saanich Mountain, near Victoria, British Columbia.

A conference of observers and students of meteorology and allied subjects is to be held in Edinburgh from September 8 to 12.

The non-magnetic yacht, *Carnegie,* under the command of J. L. Ault, arrived at Hammerfest, Norway, on July 3, twenty-five days out from Brooklyn. Magnetic and electric observations were secured on the entire trip. The results agree well with those obtained on the *Carnegie* in 1909.

The Robert Koch Foundation offers a prize of $750 for the best article on "The Importance of the Various Forms of Radiation (Sunlight, Roentgen Ray, Radium and Mesothorium) for the Diagnosis and Treatment of Tuberculosis." The articles, which must be in German, must be in the hands of the secretary of the foundation, Professor Schwalbe, not later than July 1, 1915.

The list of civil list pensions granted by the British government during the year ended March 31 last includes, according to *Nature,* the following grants for scientific services: Mr. A. J. M. Bell, in recognition of his valuable contribution to geology and paleontology, £60; Mrs. Traquair, in consideration of the services to science of her husband, the late Dr. R. H. Traquair, F.R.S., and of her own artistic work, £50; Mrs. Gray, in recognition of the valuable contributions to the science of anthropology made by her husband, the late Mr. John Gray, £50; Mrs. Wallace, in consideration of the eminent services to science of her husband, the late Dr. Alfred Russel Wallace, O.M., F.R.S., £120; Mrs. Alcock, in recognition of the valuable contributions to the study of physiology made by her husband, the late Professor N. H. Alcock, £50; Mrs. Ward, in recognition of the eminent services of her husband, the late Professor Marshall Ward, F.R.S., to botanical science, £40; Dr. Oliver Heaviside, F.R.S., in recognition of the importance of his researches in the theory of high-speed telegraphy and long-distance telephony, in addition to his existing pension, £100; Miss

Hearder, in consideration of the contributions to electrical science and telegraphy of her late father, Dr. J. N. Hearder, £70; Miss Willoughby, in consideration of the services of her late father, Dr. E. F. Willoughby, in connection with questions of public health, £30.

The third biennial meeting of the New England Federation of Natural History Societies was held at the Glen House, White Mountains, during the first week in July. Delegates from a dozen of the federated societies joined in a survey of the flora and fauna about timber line on the Presidential Range. Among those present were C. W. Johnson, curator of the Boston Society of Natural History (diptera), W. T. M. Forbes, of Worcester (lepidoptera); J. H. Emerton, secretary of the federation (arachnidæ); John Ritchie, Jr., president (mollusca), and E. B. Chamberlain, New York; Tracy Hazen, Barnard College; M. A. Chrysler, Orono, and others in the different groups of botany. Mr. Johnson reports the taking of much interesting material which serves to corroborate and define the work of the earliest botanists and W. S. Hunt, of Lynn, visited the station for Sibbaldia and reported on it.

The joint meeting of the Vermont Botanical Club and Vermont Bird Club was held during the second week in July at Fairhaven, Vt., the two presidents, Dr. Ezra Brainerd, of Middlebury, and Professor G. H. Perkins, of Burlington, being in attendance. The former led the botanical trips and the latter cared for the other interests. About twenty-five were present, covering the length and breadth of the state. Collections were made in the cedar swamp at Fairhaven, which yielded a number of rare species of plants and on the cliffs overlooking the Poultney River in West Haven, places that have been little visited by botanists. President Brainerd announced that the check list of the plants of Vermont, prepared by the club, will shortly be published by the experiment station at Burlington. The company received the courtesies of the board of trade of Fairhaven, which furnished transportation to the distant portions of West Haven and thus greatly aided the collectors.

A report by Edson S. Bastin on the production of graphite in 1913, just issued by the U. S. Geological Survey, describes the properties, uses and origin of graphite, records the production and imports in 1913, and describes the mode of occurrence at most localities where it has been quarried in the United States and at foreign localities which contribute to our domestic consumption. The island of Ceylon is the world's greatest graphite-producing center and the United States absorbs about one half of its product. Other countries that contribute graphite to our industries are Korea, Madagascar and northern Mexico. These large drafts on foreign sources, amounting in 1913 to 28,879 short tons, valued at $2,109,791 are in marked contrast to the small domestic production of natural graphite, which in 1913 was only 4,775 tons, valued at $293,756. As it has been fully demonstrated that natural graphite occurs in our own country in practically inexhaustible quantities, the question arises, Why should our industries be so dependent on foreign supplies? The reason lies in the mechanical difficulty in concentrating the American product. Most of the graphite found in this country occurs in small flakes in banded rocks known as schists. The graphite forms only 5 to 10 per cent. by weight of the rock, and the crushing of the rock and clean separation of the graphite flakes have proved commercially successful only in a few favored places. A number of new methods are now being tried which it is hoped will prove more efficient—notably the electrostatic process that has been applied with so much success to the treatment of zinc ores. The shortcomings of the United States in the production of natural graphite are in part atoned for by the large amounts of graphite produced in the electric furnaces at Niagara Falls. From its commercial inception in 1897 the industry of manufacturing graphite has grown rapidly until in 1913 the output was valued at nearly a million dollars. The various grades of manufactured graphite are adapted to practically all the uses to which graphite has been applied except crucible-making.

UNIVERSITY AND EDUCATIONAL NEWS

AN additional gift of $60,000 for dormitories at Cornell University is announced from the anonymous donor who gave the original $100,000.

AN anonymous donor has made a gift of £10,000 to the general endowment of the Royal Technical College, Glasgow, on condition that another sum of £15,000 is promised within a year.

THE Johns Hopkins Hospital is preparing to celebrate the twenty-fifth anniversary of its opening next October. The celebration will begin on October 5, with a meeting at which Dr. William H. Welch will preside and Sir William Osler, of Oxford University, will speak. On October 7 the new Brady Urological Institute will be dedicated.

WITH the registration for the summer session at Columbia University practically complete, there are 5,625 students; the largest number, by more than a thousand. It is the thirteenth year of the session, and with the exception of the years 1903–06, when the number remained at about 1,000, the increase in numbers has been by larger percentages each year. Last year the attendance was 4,530; the year before, 3,602; and 2,973 in 1911, while that of the first year, 1902, was 643.

THE trustees of the University of Pennsylvania have voted to admit women to the school of medicine of the university, beginning in the fall of 1914.

DR. HAROLD PENDER, professor of electrical engineering, Massachusetts Institute of Technology, and director of the research division of the department of electrical engineering, will become professor in charge of the department of electrical engineering at the University of Pennsylvania next fall.

DR. WALTER RAY BLOOR, of the medical school of Washington University, St. Louis, has been appointed assistant professor of biological chemistry in the Harvard Medical School.

IN the medical school of the University of Alabama Dr. William H. Clarke has been appointed professor of anatomy and Dr. J. Howard Agnew, formerly first assistant in the department of medicine of the University of Michigan, to a full-time professorship.

IN the medical department of the University of Louisville the following appointments are announced: Dr. Leon L. Solomon, professor of medicine and clinical medicine; Dr. David C. Morton, professor of clinical medicine; Dr. Sidney J. Meyers, professor of medicine and medical economics; Dr. Frank W. Fleischhaker, professor of physical diagnosis, and Dr. F. Stuart Graves, Boston, professor of pathology and bacteriology, vice Dr. Leon K. Baldauf, resigned.

THE following changes and promotions in the faculty of the Maryland Agricultural College and Experimental Station are announced: The organization of the extension and demonstration service, of which Professor T. B. Symons, of the School of Horticulture is appointed director. To this service the following transfers from the college and experiment station staff are made: Nickolas Schmitz, agronomist; W. T. L. Taliaferro, in charge of farm surveys and management; G. E. Wolcott, in charge of dairy extension; C. L. Opperman, poultryman, and Reuben Brigham. The Agricultural College is reorganized into divisions as follows: Division of agronomy and animal husbandry, W. T. L. Taliaferro, acting dean; division of applied science, H. B. McDonnell, dean; division of horticulture, T. B. Symons, dean; division of rural economics and sociology, F. B. Bomberger, dean, and division of engineering, T. H. Taliaferro, dean. Promotions in the faculty: R. N. Cory, associate professor of entomology to be professor of zoology; L. B. Broughton, associate professor in chemistry to be professor of analytical chemistry; Grover Kinzy, assistant professor of agronomy, to be associate professor of agronomy and farm machinery.

AT the University of Birmingham, according to *Nature*, Dr. J. S. Anderson has been appointed assistant lecturer and demonstrator in physics for one year in succession to Dr. Fournier d'Albe. Mr. W. Hulse has been appointed demonstrator in mining in succession to Mr. Clubb. Mr. Gilbert Johnson has received a research position in the zoological department.

DISCUSSION AND CORRESPONDENCE

NOTES ON THE FOSSIL VERTEBRATES COLLECTED ON THE COPE EXPEDITION TO THE JUDITH RIVER AND COW ISLAND BEDS, MONTANA, IN 1876[1]

As I was Professor E. D. Cope's assistant on the above expedition, and as such diverse opinions are held regarding the stratigraphy of this Montana district, I have thought it of interest to try and disentangle the muddle, and to show that the Montana beds are to be correlated with those of Red Deer River, Alberta, on the evidence of their vertebrate fossils.

The following list gives the species collected by us in 1876, and described by Professor Cope, in camp on Dog Creek, four miles east of Judith River. I mention only the specimens I remembered positively, and collected (or handled), from the top of the "bad-lands" on Dog Creek. We were camped on the narrow flood plain, and every morning at daybreak we mounted our horses and climbed to the top of the strata, where our real work began. We passed over what Cope called the Pierre and Fox hills groups of Dr. Hayden, to the latter's typical locality, from which he secured the material described by Dr. Leidy, viz., of *Trachodon, Deinodon, Trionyx,* etc. We secured many specimens of these types, and many Cope described as new to science. Among them are the following: *Myledaphus bipartitus* Cope, *Hedronchus sternbergi* Cope, *Trionyx foveatus* Leidy, *Trionyx vagans* Cope, *Compsemys imbricarius* Cope, *Compsemys victus* Leidy, *Compsemys obscurus* Leidy, *Deinodon horridus* Leidy, *Deinodon* (*Aublysodon*) *lateralis* Cope, *Deinodon hayzenianus* Cope, *Deinodon* (*Lælaps*) *incrassatus* Cope, *Palæoscincus costatus* Leidy, *Dysganus encaustus* Cope, *Dysganus haydenianus* Cope, *Dysganus bicarinatus* Cope, *Dysganus peiganus* Cope, *Trachodon mirabilis* Leidy, *Diclonius pentagonus* Cope, *Diclonius perangulatus* Cope and *Diclonius calamarius* Cope.

We then followed the prairie forty miles down to Cow Island, and went into camp three miles below the landing on the opposite (south) side of the Missouri River. Here no teeth, fragments of bones nor turtle shells were found on the surface, as on Dog Creek.

It was possible to locate the bones in one way only, viz., by noticing the color of the surface dust above the bones, which in all cases differed from that of the surrounding disintegrated rock. By digging beyond the action of the frost we found the following species of Cope—*Monoclonius crassus, Monoclonius spenocerus, Monoclonius recurvicornis* and *fissus.* The *Monoclonius crassus* was found by Cope, at least the type; Mr. Isaac also got a *crassus.* Cope's specimen was found on the south side of the river in the hills about three miles below Cow Island. My specimens of which I got *recurvicornis* and *spenocerus* came from the north side of the river about four miles below Cow Island Landing, and Mr. Isaac's a mile farther down on the same side of the river, both near the flood plain.

I had the pleasure last year, and the year before, of exploring the Edmonton and Belly River series of Red Deer River, Alberta, and to me the succession of the rocks appears to be the same as in Montana, from the mouth of the Judith River to Cow Island.

At Dog Creek are the typical Judith River beds of Hayden and Cope, followed below by the Fox-Hill-Pierre, which are in turn underlain by the Cow Island beds, the Judith River beds correlating with the Edmonton, and the Cow Island with the Belly River series.

In descending Red Deer River last June from Drumheller to Berry Creek, a distance of eighty miles, the Pierre beds were seen appearing from beneath the Edmonton, and the Belly River from beneath the Pierre.

The evidence of the fossils corroborates the distinction between the Cow Island beds and the Judith River beds at Dog Creek. The trachodonts of the Belly River formation, for instance, are quite distinct from those of the Judith River and Edmonton. Take, for example, *Gryposaurus notabilis* Lambe, with its short heavy skull, high quadrate and elevated nasal. Again the resemblance of the Belly

[1] Published with the permission of the Director of the Canadian Geological Survey.

River *Ceratopsia* to those of the Cow Island beds is marked. Lambe's *Centrosaurus apertus* is much like Cope's *Monoclonius crassus*. The skull of the great spiked dinosaur *Styracosaurus albertensis* Lambe, the most unique of the horned dinosaurs, appears to be related to Cope's *Monoclonius sphenocerus*. The Edmonton *Trachodon* secured from Macheche Creek six miles above Drumheller, on the Red Deer River, Alberta, is closely related to *Trachodon annectens* from the Lance formation.

CHARLES H. STERNBERG

GEOLOGICAL SURVEY OF CANADA

"HYDRAULICS" IN THE ENCYCLOPEDIA BRITANNICA

TO THE EDITOR OF SCIENCE: While examining the article "Hydraulics" in the eleventh edition of the Encyclopædia Britannica, Vol. 14, p. 35, I discovered three errors, one of which, at least, is worthy of note in SCIENCE, as it may cause some one to lose valuable time if the published figures are taken too seriously.

The first and most serious of these errors is the value of the coefficient of viscosity for water at 77° F. which is stated to be 0.00000191 in lbs. per sq. ft. per unit velocity gradient in feet per second.[1]

The correct equation for this value in C.G.S. units is

$$\text{Coefficient of viscosity} = \frac{0.0178}{1 + .0337t + .000221t^2}$$

t being in centigrade degrees.[2]

If the numerator be multiplied by the number of square centimeters in one foot and divided by the number of dynes in one pound while the value of t is replaced by $(t - 32) \times 5 \div 9$, the expression for the coefficient of viscosity will become

$$\textbf{Coefficient of viscosity for water} = \frac{0.0000372}{.4700 + .0144t + .000068t^2}$$

the units being the foot, pound and Fahrenheit degree.

If 77 be now substituted for t the result will be the value of the coefficient for water at 77° F., or, 0.0000188, which is nearly ten times the value given by the Encyclopædia Britannica.

[1] See p. 35, upper right-hand part.

[2] See p. 536, Lamb's "Hydrodynamics," 1906.

Another error occurs in the same article, p. 77, near the top, equation (4). The last sign in the right-hand member should be a minus sign instead of a plus sign. The correct equation is

$$H_1 = \sqrt{(2u_0^2 H_0 \div g + \tfrac{1}{4}H_0^2)} - \tfrac{1}{2}H_0. \qquad (4)$$

In Fig. 168, p. 90, the curve marked "Exper. III." should be marked "Exper. I." and the curve marked "Exper. I." should be marked "Exper. III.," the numerals evidently being transposed.

The error in the coefficient of viscosity was carried forward from the ninth edition of the Encyclopædia Britannica and was noted by me in 1909 in a paper on backwater published in *The Minnesota Engineer*, University of Minnesota.

B. F. GROAT

SCIENTIFIC BOOKS

Principles of Stratigraphy. By AMADEUS W. GRABAU, S.M., S.D., Professor of Paleontology in Columbia University. New York, A. G. Seiler and Co. 1913. Pp. xxxii + 1185 + index, with numerous illustrations.

This is a monumental work, one which presents fully and systematically the newer viewpoints in the interpretation of the rocks as the record of geologic history. For this reason it will be of great value, especially to the younger generation of American geologists, in broadening their mental horizon and outlining the problems which rise for solution in the twentieth century study of the rocks. It differs from other manuals in the English language to such a degree that it supplements but does not supplant them. It contains a notably large incorporation of material from German sources and makes full use of recent critical literature of both foreign and American authors. Nearly all of the older geologic manuals, although valuable encyclopedias of geologic science, have stored up the proven knowledge of the past, but have not pointed out the fields for investigation. They have further emphasized facts and principles as explaining facts, rather than as criteria of interpretation. This work contains a wealth of facts, though differing quite largely from that assemblage which has been carried down

in English manuals; but it is in the presentation of the facts as a basis for the interpretation of the past that it shows a different point of view.

The author has made large use of physiographic data. In fact, many chapters could be used without change in a work on physiography. This the reviewer regards as an element of great strength in the book. Physiography, a younger member of the family of geological sciences, rests upon a stratigraphic and structural foundation. The present can not be understood without a knowledge of the past. On the other hand, the past can not be interpreted without an understanding of the present, but stratigraphers and students of historical geology have not learned as yet to make full use of physiographic principles. It is the purpose of an investigation which should determine the classification of the field of science rather than the facts which are used. Defined by this standard, physiography is that division of geology whose purpose is to explain the present; the purpose of stratigraphy and historical geology is to explain the past. But as both involve an understanding of past and present, no man can work to advantage in either field without a knowledge of both. For these reasons Grabau rightly regards the work of W. M. Davis as of great importance for the principles of stratigraphy.

The aim and scope of a volume are best shown by a statement of the conditions which developed its need and led to its production. Quotations from the author's preface will best give this view.

This book is written for the student and for the professional geologist. It aims to bring together those facts and principles which lie at the foundation of all our attempts to interpret the history of the earth from the records left in the rocks. Many of these facts have been the common heritage of the rising generation of geologists, but many more have been buried in the literature of the science, especially the works of foreign investigators, and so have generally escaped the attention of the student, though familiar to the specialist. Heretofore there has been no satisfactory comprehensive treatise on lithogenesis in the English language, and we have had to rely upon books in the foreign tongue for such summaries. It is the hope of the author that the present work may, in a measure, supply this need.

The book was begun more than fifteen years ago, and the material here incorporated has been collected and sifted during this interval. . . .

The "Einleitung in die Geologie als historische Wissenschaft" had appeared only a few years before, and its influence in shaping geologic thought, especially among the younger men, was just beginning to be felt. The "Lithogenesis der Gegenwart" presented such a wealth of facts concerning the origin of sedimentary rocks, that attention began to be diverted from the problems of the igneous rocks which had heretofore almost exclusively occupied petrographers, and "Sediment-Petrographie," or the petrography of the sedimentary rocks, attracted more and more of the younger geologists, especially in Germany and France. . . .

It was at this period, too, that the attention of geologists and especially stratigraphers was first seriously directed toward the desert regions of the world and the phenomena of extensive subaërial deposition. Here, again, Walther led the way in that classic, "Die Denudation in der Wüste," followed in 1900 by his epoch-making book, "Das Gesetz der Wüstenbildung," which, in its revised edition, appeared in 1912. It is, of course, true that important studies of the desert regions were made earlier, notably those of von Zittel on the Libyan desert (1883), but the significance of the desert deposits in terms of stratigraphy was first fully appreciated within the last decade. That the importance of the desert as a geological factor has become widely recognized is shown by the numerous recent studies, especially those on the Kalahari by Passarge, and those on the Asiatic deserts, by Sven Hedin, Pumpelly, Huntington and others.

It is during this decade that the sciences of glyptogenesis and geomorphology have come into being, notably through the labors of Davis in America, and of Suess and Penck in Europe. Suess's "Antlitz der Erde" began to appear, it is true, in 1883, but it is only in recent years that this work has been readily accessible to most American students, through the medium of the English translation by Sollas and Sollas (1904–1909). Penck's "Morphologie der Erdoberfläche" appeared in 1894, but did not become well known in this country until much later. It was, however, Davis's publications in this country, chiefly during the early nineties of the last century, which gave

the great impetus to the study of land forms, and especially of the influence of erosion on their production. The concept of the peneplain, of the cycle of erosion, of the sequential development of rivers and erosion forms on the coastal plain and on folded strata, and others chiefly due to him, have become of incalculable value to the stratigrapher. The more recent development of the idea of desert planation by Passarge and Davis has opened further promising fields to the stratigrapher, who seeks to interpret the record in the strata by the aid of modern results achieved by universal processes.

In the field of correlative stratigraphy the past decade has likewise seen striking advances. The publication of the "Lethæa" falls into this period, and so does Marr's comprehensive little volume, "The Principles of Stratigraphical Geology," not to mention the elaborate recent texts of Haug, Kayser and others, or the numerous publications of government surveys, and of individual contributors. That questions of correlation have reached an acute stage in American geology is manifested by such recent publications as the "Outlines of Geological History" and Ulrich's "Revision of the Paleozoic Systems," and the numerous papers accompanying or called forth by these. Finally, paleogeography, as a science, is of very recent development, most of the works of importance having appeared in the last five years. In America Schuchert and Bailey Willis are the acknowledged leaders, while in Europe many able minds have attacked the problems of paleogeography from all angles.

It is thus seen that this book was conceived during the period of initial reconstruction of our attitude toward the problems of geology, and that its birth and growth to maturity fell into that tumultous epoch when new ideas crowded in so fast that the task of mastering them became one of increasing magnitude and, finally, of almost hopeless complexity. To summarize and bring together the ideas of the past decade, and focus them upon the point of view here essayed, is probably beyond the power of one individual. Nevertheless, the attempt to present the essentials of the new geology for the benefit of those who, grown up with it, have perhaps treated it with the lack of consideration usually bestowed on a contemporary, as well as for those who will carry on the work during the next decade or two, can not but serve a useful purpose. May this attempt be adjudged not unworthy of its predecessors, nor unfit to stand by the side of its contemporaries.

Having given the author's point of view, there may be noted briefly the especial features of some of the chapters.

In Chapter II., on the atmosphere, in addition to a review of meteorological principles, there is an extensive treatment of wind erosion and transportation. Space is given also to the indications and nature of rhythmic climatic changes.

The hydrosphere is treated in the next three chapters. Under Morphology and Subdivisions of the Hydrosphere are considered the forms of oceans, lakes and rivers. The most pertinent assemblage of material of this section is, however, in that chapter dealing with the movements of the hydrosphere and their geological effects, especially in the transportation and shaping of material.

There follows in Chapter VI. a classification of the rocks of the earth's crust.

The heart of the volume is found, however, in ten chapters, IX. to XVIII., inclusive, which deal with the original structures and lithogenesis of the sedimentary rocks, and it is for this section of 417 pages, if the reviewer mistakes not, that the work will be regarded as most distinctively a contribution to geologic science. There is throughout an application from present sedimentation to ancient sediments, more especially to those of the Paleozoic. If this section be compared with those dealing with the nature of sedimentary rocks in the standard manuals of geology in the English language, it will be seen that not only is it many times more comprehensive and extensive, but that traditional, over simple, and conventional interpretations are retested by the appeal to nature. This section leads to the conclusion that a much larger part than has been the custom should be ascribed in earlier ages to eolian and fluviatile sedimentation and their climatic implications.

Chapters XIX. to XXIII., inclusive, give 164 pages to metamorphism, earth sculpture, igneous activity and diastrophism. Parts of these chapters are better and more fully treated in other works and are not clearly within the province of the book, but other

parts, such, for example, as that on subaquatic gliding of sediments, are novel, are well treated, and valuable for their bearings on the origin of certain structures and relations of stratified rocks.

The next section of 187 pages deals with the biosphere. There is given a classification of the organic kingdom and the relations of each group to its environment. The principles which control the geographic distribution of animals are also set forth.

A final section deals with the principles of classification and correlation of geologic formations.

One of the most valuable features of the volume consists of the bibliographies which are given at the end of each chapter and the frequent references to the more important papers on each subject. The work thus is a guide to the student for his independent navigation and exploration upon that ever-broadening and rising ocean of literature which threatens to drown research.

From this statement of contents it is seen that the work is a notable contribution. Every geologist dealing with stratigraphic or historical geology should give it a place in that elect reference shelf, the revolving book case within reach of his office chair.

To prove that this eulogistic review is the result of a judicial study of the volume it is necessary, however, to supplement the previous statements by finding something for adverse comment, even if only of minor importance. A good deal of space has been given to the discussion of secondary structures—faults, folds, metamorphism, igneous intrusion, etc. This has added to the bulkiness and cost of the volume without adding proportionately to an increase in its value. This greater cost will tend to keep it on the reference shelves of libraries instead of installing it in the private library of every student. The book is consequently likely to have less influence than if the detailed discussion of secondary structures had been ruled out or published as a separate volume. The subject matter does not appear sufficiently essential for the principles of stratigraphy to require incorporation, and a comprehensive study of these fields requires furthermore the study of other treatises, such as those of J. Geikie, Van Hise and Leith.

Classification is necessary in order to deal with the subject-matter of science, and classification must grow with the growth of knowledge. One of the noteworthy features of the work is the development of systematic classification to cover the field of sedimentation and stratigraphy. It aids in a logical and precise treatment, but the reviewer thinks that the author may have partially hindered his purpose by an over-classification and the extensive coinage of unfamiliar Greek names. Such words as caustobioliths and sapropelcalcilyths are examples. The renaming of contact metamorphism as æthoballism and dynamic metamorphism as symphrattism seems unnecessary and is hardly likely to succeed. To discuss earthquakes under the division of the centrosphere seems also quite inappropriate. "The littoral" in its original meaning and as used by a number of geologists has been restricted to the zone of shore between high and low tide. The stratigraphic characters are unique in that they receive the impress of alternate exposure to the air and sea. This dual relation must be recognized in order to avoid the inherited confusion between continental and marine deposits. The reviewer regards it as unfortunate, therefore, to extend it as a general term as is here done to cover all that region from the high-tide line to the edge of the continental shelf. This in some regions is more than 100 miles from the shore and in ancient times was often vastly farther. On the other hand, however, it should be noted that the refinement of classification adds greatly to the analysis of the original structure and lithogenesis of the continental sediments, divided under the heads of atmoclastic, anemoclastic and hydroclastic rocks, assisting in a better presentation of these groups than has heretofore appeared.

An enumeration and discussion of the multiple hypotheses which may participate in complex processes is of great value to the advanced student, opening his mind to various possibilities and stimulating his imagination to

new research. Through most of the book this is very well done, but the causes of climatic change through geologic time do not find adequate treatment. There is, for instance, a rather extensive presentation and commendation of the several hypotheses of a wandering pole, but almost no discussion of the influence of changing atmospheric composition and none of such factors as a possible reversal of the oceanic circulation or possible changes in solar radiation. The absence of a dynamic proof of polar wandering adequate to account for climatic change makes it seem to the reviewer the least supported of all the climatic hypotheses.

To sum up this volume in a sentence—it is in the broad and admirable treatment of the present processes of sedimentation and in the interpretations which they give to the older sedimentary rocks that the book will be found to have its unique value.

JOSEPH BARRELL

Some Fundamental Problems in Chemistry. By E. A. LETTS. New York, D. Van Nostrand Co. 1914. 15 × 22 cm. Pp. v + 235. Price $2.50.

In the preface the author says that one of his "chief ideas was to contrast certain ancient views, such as those of atoms and a primordial element or primordial elements in the shape of air, earth, fire, and water, together with the possibility of transformations of these latter into each other, with the modern conception of electrons and the discovery of changes, such as those which the radioactive elements experience, which amount in fact to a change of one so-called chemical element into others. . . ." It is perhaps a question whether many readers will agree with the author that these two modern discoveries prove that even in science history may repeat itself; but fortunately one may like the book without accepting the author's thesis.

The book consists of four chapters on the older chemistry and seven on the newer chemistry. Under older chemistry the subheads are: ancient theories regarding the nature of matter and more recent theories as to the nature of energy; the atomic theory and atomic weights; the periodic law. There is nothing especially interesting or novel about this portion of the book and it might well have been omitted, thus giving the author an opportunity to amplify the portion on the newer chemistry, which is very interesting.

The newer chemistry, as understood by the author, deals with the effects of electrical discharges on gases in high vacua, radioactivity, Lockyer's theory of inorganic evolution, and Arrhenius's views on the birth and death of worlds. This part is admirable though distinctly not critical. The author apparently accepts, without much reservation, all the transmutations which Ramsay has described.

With Plücker tubes as a starting-point the author discusses the production of cathode rays when the degree of exhaustion is increased, and the properties of these rays. From cathode rays he passes to canal rays and thence to Röntgen rays. After that come Becquerel rays and then the discovery of radium by the Curies. The properties of the α, β, and γ rays are discussed and then the decomposition products of radium. The facts in regard to the production of helium are followed by an account of Ramsay's experiments on the alleged formation of lithium, carbon and neon. The author does not point out, as he well might have done, that it would be in the interest of science for Ramsay either to accept Mme. Curie's work on lithium or to repeat it and show wherein the discrepancy occurs. The present state of things is distinctly not creditable, and Ramsay's unwillingness to meet the situation raised by Mme. Curie's work on the alleged production of lithium has caused Ramsay's work on the alleged production of carbon and neon to be received with much suspicion. The last chapter on radioactivity deals with J. J. Thomson's discussion of the periodic law on the basis of the electron theory.

The chapter on inorganic evolution may be summed up as follows: In the very hottest stars we find hydrogen, helium, asterium and doubtless other gases still unknown. At the next (lower) temperatures, we find these gases

becoming replaced by metals in the state in which they are observed in the laboratory, when the most powerful jar spark is employed. At a lower temperature, the gases disappear almost entirely, and the metals occur in the state produced by the electric arc. These changes are simply and sufficiently explained on the hypothesis of dissociation.

The final chapter on the birth and death of worlds is based on Arrhenius's book entitled "Worlds in the Making." Arrhenius takes up the questions of the creation and of the eventual destruction of the stars and of worlds like our own, and gives reasons for believing that both operations are simultaneously occurring in cosmos, or, so to speak, a "winding up" and a "running down" of the machinery of the universe; the two chief forces at work being the mechanical pressure of light, or simply the "radiation pressure," on the one hand, and gravitation on the other.

Wilder D. Bancroft

PROPOSED INTERNATIONAL MAGNETIC AND ALLIED OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE OF AUGUST 21, 1914 (CIVIL DATE)

In response to an appeal for simultaneous magnetic and allied observations during the coming total solar eclipse, cooperative work will be conducted at stations along the belt of totality in various countries and also at some outside stations.

The general scheme of work proposed by the Carnegie Department of Terrestrial Magnetism embraces the following:

1. Simultaneous magnetic observations of any or all of the elements according to the instruments at the observer's disposal, every minute from August 21, 1914, 10^h A.M. to 3^h P.M. Greenwich civil mean time, or from August 20, 22^h to August 21, 3^h Greenwich astronomical mean time.

(To insure the highest degree of accuracy, the observer should begin work early enough to have everything in complete readiness in proper time. See precautions taken in previous eclipse work as described in the journal *Terrestrial Magnetism,* Vol. V., page 146, and Vol. VII., page 16. *Past experience has shown it to be essential that the same observer make the readings throughout the entire interval.*)

2. At magnetic observatories, all necessary precautions should be taken to insure that the self-recording instruments will be in good operation not only during the proposed interval but also for some time before and after, and eye-readings should be taken in addition wherever it is possible and convenient. (*It is recommended that, in general, the magnetograph be run on the usual speed throughout the interval, and that, if a change in recording speed be made, every precaution possible be taken to guard against instrumental changes likely to affect the continuity of the base line.*)

3. Atmospheric-electric observations should be made to the extent possible with the observer's equipment and personnel at his disposal.

4. Meteorological observations in accordance with the observer's equipment should be made at convenient periods (as short as possible) throughout the interval. It is suggested that, at least, temperature be read every fifth minute (directly after the magnetic reading for that minute).

5. Observers in the belt of totality are requested to take the magnetic reading every thirty seconds during the interval, 10 minutes before and 10 minutes after the time of totality, and to read temperature also every thirty seconds, between the magnetic readings.

It is hoped that full reports will be forwarded as soon as possible for publication in the journal of *Terrestrial Magnetism and Atmospheric Electricity.*

L. A. Bauer

Washington,
June 23, 1914

SPECIAL ARTICLES

AMMONIFYING POWER OF SOIL-INHABITING FUNGI

A comparatively large amount of work has been done on the power of soil bacteria to produce ammonia from the nitrogenous materials found in the soil, or from organic materials such as dried blood or cotton seed meal added

to the soil. A comparatively small amount of work has been done on the power of soil-inhabiting fungi to produce ammonia under like conditions. Müntz and Coudon[1] demonstrated that the production of ammonia from the organic matter in soils is a property common both to molds and to bacteria. It is interesting to note that they used both bouillon and one hundred gram portions of soil, with manure added as culture media. In their investigations they used two pure cultures of molds, *Mucor racemosus* and *Fusarium Muentzii*. Later Marchal[2] confirmed their results.

In a series of investigations which were carried on for the purpose of determining the effect of acid phosphate on the ammonification of dried blood in soils, we observed that with varying percentages of acid phosphate the amount of ammonia accumulated in one particular type of soil increased with the increase of acid phosphate from 0.25 per cent. to 2 per cent. There was but a slight decrease of ammonia in the soil receiving 5 per cent. of acid phosphate. In fact, there was over one half more ammonia accumulated in the soil containing 5 per cent. of acid phosphate than in the soil to which no acid phosphate had been added. It was also observed that there was a very heavy growth of molds on all soil portions receiving acid phosphate. Counts were made of bacteria in the soil portions, and it was found that there was a decrease from 240,000,000 bacteria per gram of soil in the portions containing 0.5 per cent. of acid phosphate to 12,200,000 in the soil portions receiving 5 per cent. of acid phosphate. The opposite effect was noted in using certain other soils. There was no appreciable growth of molds in these soils, and the amount of ammonia accumulation decreased with increased quantities of acid phosphate. This was exactly the opposite of what was to be expected as several investigators have held that molds use ammonia for the development of their mycelium. From these results we were led to conclude that there was either a modification in the character or number of ammonifying bacteria present, or that it was due to the ammonifying power of the large number of fungi present in this soil and that this activity was stimulated by the addition of a large quantity of acid phosphate.

[1] *Compt. Rend. Acad. Sci.*, Paris, 116: 395. 1893.

[2] *Bull. Acad. Roy. Belgique*, III., 25: 727. 1893.

Several plates which showed a considerable number of mold colonies were set aside to allow further development. Various fungi were separated into pure cultures. Of these the commonest were *Zygorhynchus Vuilleminii*, *Rhizopus nigricans*, and certain species of *Penicillium*. To guard against possible contamination of the plates by spores from the air, these fungi were reinoculated into the soil from which they were isolated. Their growth in this medium determines their status as soil-inhabiting fungi. The fungi so secured include, in addition to those already named, species of *Alternaria*, *Aspergillus* and *Trichoderma* and several species of *Mucor*. One other species, *Monilia sitophila*, was isolated from soils, which had been heated to a high temperature in the autoclave.

As the decomposition of the nitrogenous materials in soils is influenced to a certain extent by their chemical and physical composition and by their reaction, two soil types were used; one of these was a gravelly loam acid soil, the other a red shale neutral soil. Identical methods were used in the ammonification studies. One hundred gram quantities of sterile soil were used. The "beaker method"[3] was employed. Dried blood and cotton seed meal were used as sources of nitrogen, amounts of these containing 155 mgs. of nitrogen were used in each case. The cultures were incubated at 20° C. for seven days, and the ammonia determined.

There was found to be a considerable difference in the power of the various soil fungi studied to ammonify dried blood and cotton seed meal in the soil; that is, in their ammonifying efficiency. A comparison of all of these fungi was made in the loam soil, using dried blood as a source of nitrogen. In all cases but one the addition of two grams of acid phosphate increased the ammonifying effici-

[3] N. J. Experiment Station Report, 1908: 129.

ency. It is interesting to note that with a single exception there was an increased growth of mycelium, with increased ammonia accumulation. In the case of *Zygorhynchus,* there was but a slight growth of mycelium, although a fairly large amount of ammonia was accumulated in the soil. Of the cultures studied, *Trichoderma* showed the largest ammonifying efficiency, which was 48.52 per cent. in soil not containing acid phosphate, and 58.39 per cent. in soil containing 2 per cent. of acid phosphate. On the other hand, *Penicillium I.* showed an ammonifying efficiency of 21.39 per cent. in soil containing no acid phosphate, and 16.45 per cent. in soil containing 2 per cent. of acid phosphate. *Penicillium VI.* showed a very low ammonifying efficiency, which was 10.75 per cent. without acid phosphate, and 12.15 per cent. with 2 per cent. acid phosphate added. A comparison was made of the ammonification of dried blood and cotton-seed meal in the two different soils, inoculating them with *Penicillium VII.* and *Rhizopus nigricans.* More ammonia was accumulated in each soil from cotton-seed meal than from dried blood in the case of both fungi.

The addition of calcium carbonate appeared to inhibit the ammonification of dried blood in the red shale soil with *Rhizopus* and *Penicillium VII.,* but the addition of even small amounts of acid phosphate increased the ammonia accumulation. From some of the results obtained, it appears that the presence of soluble phosphates in the soil, rather than its reaction, determines the amount of ammonia accumulation.

In comparing the ammonifying power of soil bacteria with that of soil fungi using dried blood in the loam soils, the highest amount of ammonia accumulated in the case of the bacteria was with *Bacillus subtilis,* which showed 54.13 milligrams of ammonia nitrogen in the portion not containing acid phosphate and 17.55 milligrams in the portion containing 2 per cent. acid phosphate. In the case of fungi, the highest amount of ammonia accumulated was by *Trichoderma* which showed 75.20 milligrams ammonia nitrogen in the portion not containing acid phosphate and 90.50 milligrams of ammonia nitrogen in the portion containing acid phosphate.

A more detailed account of these fungi and of the data accumulated by us concerning them will be published at an early date.

Harry C. McLean,
Guy West Wilson
N. J. Agricultural Experiment Station,
New Brunswick, N. J.

THE IOWA ACADEMY OF SCIENCE

The meetings of the twenty-eighth annual session of the Iowa Academy of Science were held at Iowa State Teachers College, Cedar Falls, beginning Friday afternoon, April 24, and closing at noon Saturday, the 25th. The meeting was called to order at 1:30 P.M. by the president, Professor C. N. Kinney, of Drake University. After the preliminary business was transacted the academy proceeded to the reading of papers until adjournment to meet at 9:00 A.M. Saturday.

The evening address was given by Dr. N. H. Winchell, of the Minnesota Historical Society, on "The Antiquity of Man in North America in Comparison with Europe."

Following the reading of papers and the final business meeting a luncheon was served in the gymnasium at noon, Saturday.

As officers for the ensuing year the following elections were made:

President, H. S. Conard, Grinnell.
First Vice-president, H. M. Kelly, Mount Vernon.
Second Vice-president, L. S. Ross, Des Moines.
Secretary, James H. Lees, Des Moines.
Treasurer, A. O. Thomas, Iowa City.

It was decided to try the plan at the next annual meeting, to be held at the State University of Iowa, Iowa City, of carrying out the program in two divisions: a general session and sectional meetings.

It was also recommended that the state legislature be urged to appropriate additional funds to enable the Geological Survey to complete the topographic map of the state in the least possible time.

Program

(Abstracts by the authors.)

Sulfofication in Soils: P. E. Brown and E. H. Kellogg.

The Des Moines Diphtheria Epidemic of 1912–13: Chas. A. Wylie.

Bacterial Content of Desiccated Egg: L. S. ROSS.

The results of about 550 examinations of liquid and of powdered egg are given. The problem of the effect of storage, both with reference to time and temperature of storage, is considered. Results obtained in the experiment show a more rapid diminution of bacteria in storage at incubator temperature than at room temperature. The conclusion is drawn also that good eggs carelessly handled during process of manufacture may show a greater bacterial content than eggs of suspicious quality if carefully handled during the process of breaking and drying. It seems possible that "spots" may be made into a desiccated product, which after storage for some time would give satisfactory results upon a quantitative bacterial examination.

An Incubator Opening to the Outside of the Building: L. S. ROSS.

An incubator was placed in the basement and from this a chute leads upwards and outwards to an opening in the wall of the building. The purpose of the device is to make it possible for physicians or officers of the city board of health to drop diphtheria culture tubes, submitted for diagnosis, into the incubator at any hour of the day or night.

U. S. Kelp Investigations in Alaska: ROBERT B. WYLIE.

The Pollination of Vallisnaria: ROBERT B. WYLIE.

Comparison of Field and Forest Floras in Monona County, Iowa: D. H. BOOT.

A study made during 1909 and 1910 of the floras of typical areas in Monona county, Iowa, to determine the relationship between them. Studies made of undisturbed prairie, both exposed and sheltered, of cleared forest land and of both exposed and sheltered forest show gradual transition in plant life from the most xerophytic to the most hydrophytic types of habitat. No sudden breaks occur as we go from one area to the next. Complete lists of flowering plants accompany the report.

The Origin of the Cocklebur: CLIFFORD H. FARR.

Notes on a Fossil Tree-fern of Iowa: CLIFFORD H. FARR.

The Myxomycetes of Puget Sound: THOMAS H. MACBRIDE.

Some Notes on the Ecology of Iowa Lichens: ZOE R. FRAZIER.

The following conclusions are suggested by the work for this paper.

Lichens vary in adaptation to habitat; this applies both to different species and to different individuals of the same species.

Variation in habitat is explained, at least in part, by structural adaptations. Lichens show a remarkable power of resistance to drouth.

Preliminary Report on the Flora of Linn County: ELLIS D. VERINK.

The Male Gametophyte of Arisæma: JAMES E. GOW.

Sunflecks: W. H. DAVIS.

Some Observations on Sycamore Blight and accompanying Fungi: J. P. ANDERSON.

Introduced Plants of the Clear Creek Cañon: L. H. PAMMEL.

L. H. Pammel called attention to some of the introduced plants of the Clear Creek Valley, Colorado. The first botanist to visit the region was Dr. C. C. Parry, who collected in this region in 1861. Comparatively few alien plants have been introduced; many of the introduced plants are those common to the plains or boreal species.

Weed Survey of Story County, Iowa: L. H. PAMMEL AND CHARLOTTE M. KING.

This paper gives a brief summary of the ecological distribution of weeds on tilled and untilled land in central Iowa, using the quadrat method of giving the distribution.

Variation in Evaporation in Limited Areas: D. H. BOOT.

Notes on Variation in Micranthes Texana: L. A. KENOYER.

In southeastern Kansas there is a very small patch of a little saxifrage, *Micranthes texana* (Buckl.) Small. Saxifragaceæ are normally 2-carpellate, but in this patch the carpel number varies from two to six, fluctuating around three as an average. Of the 1,800 flowers examined, 83 per cent. have three carpels each. A mutation seems to have occurred somewhere in the life history of this rare and little-known species, giving rise to a group having three as the normal number of carpels.

Barium in Tobacco and other Plants: NICHOLAS KNIGHT.

Colloidal Common Salt: NICHOLAS KNIGHT.

The Sand of Sylvan Beach, New York: NICHOLAS KNIGHT.

Unusual Dolomites: NICHOLAS KNIGHT.

Electromotive Forces and Electrode Potentials in Mixed Solvents: J. N. PEARCE AND W. H. FARR.

Equilibrium in the System—Mercuric Iodide-Anilin: J. N. Pearce and E. J. Fry.

A complete curve representing the conditions of equilibrium between mercuric iodide and anilin has been plotted for temperatures between —11.48° and 199.9°. The region of stability of the three solids $HgI_2 \cdot 2C_6N_7H$, red mercuric iodide, and yellow mercuric iodide have been established. Sixteen solubility measurements of mercuric iodide in anilin are given, all in duplicate and mostly in triplicate. A new compound corresponding to the formula $C_6H_7N \cdot HG_2I_2$ has been identified and described. The compound $HgI_2 \cdot 2C_6H_7N$ has been made by direct combination of mercuric iodide with anilin. A method for the determination of mercuric iodide as mercuric sulphide in the presence of an easily oxidized organic solvent has been tested.

The Electrical Conductivity of Solutions on Certain Electrolytes in Organic Solvents: J. N. Pearce.

Earth Movements and Drainage Lines in Iowa: James H. Lees.

The paper aims to bring together existing knowledge concerning drainage conditions in northeastern Iowa and to show that the present system is the resultant of uplifts and warpings of the strata at different periods and from various centers. The fact that the streams are flowing far above the bottoms of their valleys is attributed to changes necessitated by glacial action and to lowering of the land surface.

Some Evidences of Recent Progress in Geology: George F. Kay.

In this paper reference is made to some of the most important geological papers published during the last ten years and which indicate the lines along which the greatest progress has been and is being made.

Siouan Mountains: An Iowan Triassic Episode: Charles Keyes.

The true significance of the abrupt cutting off to the northward of the Iowa belted Paleozoics is obscured by the fact that Cretacic sediments overlie points at which critical evidence might be expected. Lately, deep-well records and other data have disclosed a substructure that is quite remarkable. It is now known that over the high arch extending from Lake Superior southwestward into South Dakota the Cambric, Ordovicic, Siluric, Devonic and Carbonic formations were spread out. The uprising appears to have taken place in Triassic times; and in Comanchan time the entire mountainous ridge, 5,000 feet high, was planed off and completely base-leveled. Upon this peneplained surface the Mid Cretacic sediments were laid down. This period of base-leveling also appears to fix the date of peneplain forming the Lake Superior highlands.

Serial Unit in Stratigraphic Classification: Charles Keyes.

The recent movement to test the validity of each formational unit by criteria other than that of the contained fossils has led to important and rather unexpected advancements in stratigraphical classification. The fact that this movement is also in the direction of simplicity argues for its still wider adoption. In Iowa, Illinois and Missouri the Early Carbonic succession is a good illustration of the point under consideration. By emphasizing the paleogeographical and diastrophic factors and adapting, so far as is possible, the nomenclature already in use the various terranes may be grouped into three grand divisions having serial rank. These groups are the Waverleyan series, the Mississippian series and the Tennesseean series. At divers times other names have been proposed, that might be used but for the fact that they are preoccupied. The division is essentially the same as that first suggested by Owen more than sixty years ago.

Stratigraphic Position of Our Oldest Rocks: Charles Keyes.

Although the Sioux quartzite, which crops out where the three states of Iowa, Minnesota and South Dakota meet, has been long known and repeatedly described, little has ever been learned of its tectonic relationships or of its real position in the general geologic column. The Corson diabases, the Hull porphyries and the Tipton sandstones now appear to belong to the Keewenawan series of the Proterozoic era. The Split-Rock slates, the Sioux quartzite and the Jasper conglomerates are Animikean in age. The Archeozoic is not represented. The gneisses of Le Mars and the schists of Sioux City form a part of the Azoic complex.

On Precious Stones in the Glacial Drift: Garrett A. Muilenburg.

A New Section of the Railway Cut near Graf, Iowa: A. O. Thomas.

This artificial section exposed along the Chicago Great Western railway in Dubuque county has been made famous by the writings of James and of Calvin. It has recently been cut back for quite a

distance while making some improvements in the road-bed.

The fresh section affords an excellent opportunity for studying this phase of the Maquoketa shales. Several feet of interesting beds higher up than those described by the writers mentioned have been exposed. The new section is described and a revised list of the fossils is given.

The Surface Clay of Adair County (Second Paper): JAMES E. GOW.

Evidences of Sand Dune Formation in Cedar Rapids and Vicinity: WASHBURN D. SHIPTON.

Pleistocene Exposures in Cedar Rapids, Iowa and Vicinity: WASHBURN D. SHIPTON.

Preliminary Report of Geological Work in Northeastern Iowa: ARTHUR C. TROWBRIDGE.

Field work is now being carried on in northeastern Iowa by students and faculty of the geology department of the State University of Iowa. Much new material is being found, along the lines of stratigraphic, structural, paleontologic, economic and physiographic geology. The region is particularly rich in physiographic problems, and a continuation of the work is expected to yield much additional knowledge of the Mesozoic and Cenozoic history of this part of North America.

The Origin of Eskers: ARTHUR C. TROWBRIDGE.

There are many difficulties with the generally accepted subglacial theory for the origin of eskers, which says that these interesting ridges are deposited by streams flowing beneath continental glaciers. It seems more likely that they are formed by the slow recession of the edges of glaciers during the deposition of kames, and a resulting drawing out of the kames into long lines.

An Area of Wisconsin Drift farther South in Polk County, Iowa, Than Hitherto Recognized: JOHN L. TILTON.

One mile south of the bridge over Raccoon River at Valley Junction there is a small area of Wisconsin drift about a third of a mile in diameter.

Indian Pottery of the Oneota or Upper Iowa Valley in Northeastern Iowa: ELLISON ORR.

The Oneota or Upper Iowa, a small river about eighty miles in length, flows through Winneshiek and Allamakee counties in Iowa close to their northern border, which is also the line between this state and Minnesota. It flows through a beautiful winding valley which has a width of half a mile, and is bounded by precipitous bluffs. The glacial terraces which extend up this valley for forty miles to Decorah have afforded very abundant evidences of a former considerable Indian population. Earth embankments, mounds and camp sites have yielded up a treasure of implements, weapons and ornaments. Notable among these are the large number of small earthen vessels found in burial places and the fewer large ones which seem to have been buried by themselves. The writer has been quite successful in finding or securing a number of well-preserved specimens of both classes, some of which he describes in detail. The material used in the manufacture was common clay tempered by pulverized clam shells. In shape this pottery is symmetrical but the attempts at ornamentation are crude. The vessels all have a rounded pot-like bottom and if upset, will at once resume an upright position. "In short, these prehistoric potters, while they were able to produce very shapely ware, were unable to add to its beauty by elaborate, intricate or symmetrical designs." The paper is illustrated by nine plates.

Longitude by Wireless: D. W. MOREHOUSE.

Illumination Power of Kerosenes Used in Iowa: WILLIAM KUNERTH.

The results of this series of experiments can be summarized as follows:

1. By the application of ordinary photometric methods great differences in the illuminating power of different samples of kerosene oils have been shown.
2. Oils from the east have a lower density and are sold at a higher price than those from the west.
3. Those oils which have a high illuminating power were found also to be high in density, index of refraction, viscosity, surface tension, flash point and burn point. The length of wick charred was shorter and the fogging of the chimney was more marked than for the oils having low illuminating power.
4. The oils which were retailed at lower cost gave more light.
5. By putting coloring matter into an oil the illuminating power is decreased.
6. By exposing oil to light, the illuminating power is decreased.
7. Draft reduces the illuminating power.
8. The denser the oil the greater is the intrinsic brilliancy of the flame.
9. Air in oil seems to decrease the illuminating power.
10. For a given flux of light the cost of illumination by kerosene oil lamps is about the same as that by tungsten lamps.
11. The oils used in this state have practically the same burning quality.
12. Kerosene oil lamps are not very desirable as standards of comparison.
13. The quantity of oil received for a gallon is often very deficient.

14. The lighter the oil the more nearly white is the flame.

Certain Diffraction Experiments in Sound: HAROLD STILES AND G. W. STEWART.

This paper describes three experiments in sound diffraction, viz., the shadow of a rigid sphere, the passage of sound through narrow slits and the sound through circular apertures.

Previous theoretical investigations are verified to within a reasonable degree in all three experiments. The paper is published in full in the *Physical Review* for April, 1914.

The Variation of Sound Intensity with Distance from the Source; An Interesting Case of Deviation from the Inverse Square Law: G. W. STEWART.

This paper shows that when a source of sound is located on a rigid sphere the intensity does not decrease inversely as the square of the distance from the source or from the center of the sphere. Data are given for the variation in intensity in different directions from the sphere, at different distances and with a variation of wave length.

Notes on the Construction of Selenium Bridges: E. O. DIETERICK.

The Adaptation of Selenium to Measurements of Energy Too Small to be Measured by Other Devices: L. P. SIEG AND F. C. BROWN.

The Effect of Pressure on the Light-sensibility of Metallic Selenium Crystals: F. C. BROWN AND L. P. SIEG.

Sex Linked Factors in the Inheritance of Rudimentary Mammæ in Swine: EDWARD N. WENTWORTH.

The Effect of Calcium and Protein Fed Pregnant Swine upon the Size, Vigor, Bone and Coat of the Resulting Offspring: JOHN M. EVVARD, ARTHUR W. DOX AND S. G. GUERNSEY.

To determine the relative effects of calcium and protein when added to a basal ration of corn when fed pregnant swine on the developing fetus many separate experiments were conducted. It was clearly shown that the addition of protein to corn increased the size, vigor, condition, coat quantity and coat covering of the offspring. Duroc Jersey swine were used; these are red in color. The addition of calcium also increased the size, vigor, condition, coat quantity and coat color, but not so markedly as did the protein. However, the calcium did have more effect on the bone development and the condition or degree of fatness than did the protein. That the addition of protein had such influence upon the offspring is due in large measure to the fact that the corn protein is deficient in the amino acids, tryptophane, lysine and glycocoll. The source of the protein was black albumen, whereas the calcium was furnished in the form of both chloride and carbonate. The carbonate was found to be more efficacious than the chloride, presumably because it did not induce acidosis as the chloride probably did.

A Study of the Crow: FRANK C. PELLETT.

Butterflies of Chance Occurrence in Cass County: FRANK C. PELLETT.

Nature and Birds: FRED BERNINGHAUSEN.

Color Vision in Animals: MABEL C. WILLIAMS.

Effect of Low Temperature on the Oyster-shell Scale, Lepidosaphes Ulmi Linn: R. L. WEBSTER.

The effect of the low temperatures of January, 1912, on the eggs of the oyster-shell scale in Iowa. An account based on samples of scale sent in a year later. In most cases the eggs had been killed by the severe winter.

A Catalogue of the Lepidoptera of Linn County: GEORGE H. BERRY.

Notes on Variation in Micranthes Texana: L. A. KENOYER.

Coleoptera of Henry County, Iowa: INEZ NAOMI KING.

There are listed about 500 species of Coleoptera representing those that are known to occur in Henry county, Iowa. Most of these species have been collected by the author during the years 1912, 1913 and 1914.

"The Coleoptera of Indiana," by W. S. Blatchley, has been used for the larger part in naming the specimens taken, although some of the names have been determined through various sources.

An Observation of Longitudinal Division of Hydra: L. S. ROSS.

An account of the observation of two specimens of the brown *Hydra* in the process of longitudinal division, one being divided through the length of the body to the foot, while the other had divided through the hypostome and only a short distance into the body. Also a brief account of the accidental injury of one of the tentacles resulting in the union of two tentacles into a loop that persisted a few days and then separated again into two distinct tentacles.

A Convenient Table for Microscopic Drawing: L. S. ROSS.

JAMES H. LEES,
Secretary